Pronghorn Procurement on the Northern Plains: A Case for Small-Scale Hunting

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Abstract

In general, when an archaeologist addresses the issue of faunal procurement on the Plains, especially the northern Plains, the model used entails the communal hunting of bison. The non-communal procurement of a secondary prey species is frequently overlooked by Plains archaeologists. It is the intent of this thesis to present a pronghorn procurement strategy that aligns itself with the current archaeological evidence, gathered from across the northern Plains.

Based on the abundance of Wyoming and Great Basin communal pronghorn procurement features, along with a single northern Plains trapping structure, the procurement of pronghorn is often regarded as a communal undertaking. However, a review of the site literature reveals that archaeological pronghorn remains are present in small quantities in numerous habitation sites situated throughout their prehistoric range. In addition, evidence for pronghorn kill sites on the northern Plains is minimal at present. This leaves one to ponder the question; why are small quantities of pronghorn remains present in campsites across the northern Plains?

The first part of this thesis addresses the above question through the examination of the unique behavioural and morphological characteristics of the pronghorn, as well as bow and arrow technology. This is undertaken in order to demonstrate the suitability of both the pronghorn and the aboriginal hunting technology to small-scale procurement. In addition ethnographic, historic and archaeological data concerning pronghorn procurement on the northern Plains are presented in a framework that allows for a revision of prevailing models concerning this activity. In addition, small-scale and communal procurement is analyzed within the theoretical framework of optimal foraging theory. This provides evidence that the small-scale hunting of pronghorn was an efficient hunting strategy and therefore it is reasonable to assume that it was practiced prehistorically.

The remainder of this thesis addresses a secondary, yet relevant, question involving the lack of visibility of pronghorn remains in the archaeological record. If pronghorn were an obtainable and useful secondary resource then why are such small quantities of bone present at archaeological sites situated within ideal pronghorn habitat? This question is explored within the context of bone survivorship. With both cultural and non-cultural reasons for the differential preservation of pronghorn remains being outlined. Specifically, carnivore attrition, weathering and trampling are explored as possible non-cultural agents that affect the archaeological visibility of pronghorn assemblages. Cultural processes include primary/secondary butchering and processing strategies as well as carcass transportation decisions are also investigated. In addition, the pronghorn assemblages from EbPi-75 and DlOu-72 are statistically tested to determine if bone density has any correlation to element frequency.

Finally, the two recently excavated northern Plains pronghorn assemblages from EbPi-75 and DlOu-72 are analyzed and compared to the existing body of archaeological research from the northern Plains, High Plains, and the Wyoming Basin. From this comparison and the thesis research in general, a new model for pronghorn procurement is developed that better suits the northern Plains archaeological record to date.

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Run, Don't Walk

Every morning on the northern Plains,
a pronghorn wakes up. It knows
that it must run faster than the fastest
coyote or it will be killed.

Every morning on the northern Plains,
a coyote wakes up. It knows that
it must outrun the slowest pronghorn
or it will starve to death.

It doesn't matter whether you are
a coyote or a pronghorn; when the
sun comes up, you'd better be
running!

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CHAPTER ONE

Introduction

1.1 Introduction to the Problem

The pronghorn (*Antilocapra americana*) is often considered by archaeologists to have been of negligible economic value to prehistoric population on the northern Plains, even though it is an often-represented component of the campsite faunal assemblage. While there are no archaeological sites on the northern Plains with abundant pronghorn remains, as compared to the Great Basin or High Plains, the number of sites containing some pronghorn remains is significant. It is the intent of this thesis to investigate several hypotheses to explain this and in the process develop a case for the small-scale procurement of pronghorn.

Anthropologists and archaeologists working on the northern Plains have devoted considerable attention to the significance of bison in Holocene hunter-gatherer subsistence economies. Less attention has been given to the role of intermediate-sized ungulates such as pronghorn, deer, elk, and bighorn sheep. These species inhabited not only the prairie ecoregion and forested margins but the physiographic and ecologic discontinuities within the grasslands of the northern Plains as well (Frison 1991a; Lippincott 1996).

The subject of prehistoric procurement of pronghorn on the Plains has received increasing attention by archaeologist in recent years (Frison 2004; Lubinski 1997, 2000), particularly in the context of communal trapping and mass kills. This has resulted in the

implementation of communal hunting as the excepted procurement model for the entire Plains area. However, the appearance of pronghorn remains in lesser numbers is a more frequent occurrence at sites throughout southeastern Alberta and southwestern Saskatchewan, a fact that undoubtedly owes to the ubiquity of the species. This is, due to a variety of factors including poor preservation, small numbers of pronghorn bones present and mixed assemblages involving the remains of more than one species. All of these specifics are indicative of small-scale pronghorn procurement and have largely been overlooked, with regards to the northern Plains.

The pronghorn, distinctive in both its evolution and behaviour, was an important source of food and clothing for the aboriginal peoples of the northern Plains. Many ethnographic and historic sources mention both the ceremonial preparation for, and the actual hunting of pronghorn. In addition, pronghorn remains are present in the faunal assemblages of numerous northern Plains sites. In spite of this, archaeological data concerning the small-scale procurement of pronghorn by aboriginal groups on the northern Plains have not been synthesized with ethnographic and zoological data on the pronghorn. A revision of several prevailing regionally specific concepts concerning pronghorn hunting that appear in the literature, and that have often been accepted by Plains researchers in lieu of a critical examination of the available data, is suggested. Various models, combined with supporting archeological data concerning the procurement of pronghorn on the northern Plains, are presented in support of a small-scale procurement hypothesis.

1.2 Statement of Objectives

This research is concerned with the interpretation of variation in archaeological pronghorn bone assemblage composition, with particular attention being paid to its

implications for the reconstruction of past human behaviour. In principle, the problem has two interdependent dimensions: (1) the identification of significant variation in the archaeological record itself and (2) the development of frameworks for interpreting it. Despite the generally inductive nature of the discipline, most archaeologists see the second as the more immediately critical. It is also agreed, despite ongoing debate, that interpretive frameworks should utilize the archaeological and ethnographic record, as well as knowledge of modern animal behavioural data.

Given that consensus, two broad sets of questions emerge:

1. How did prehistoric humans, especially those who relied on pronghorn for part of their subsistence base, create a thanatocoenosis that was incorporated into the archaeological record? How did they select their prey, process it, move it across the landscape, consume it, modify the bones in the process and discard the remains? What are the archaeological consequences of their actions, especially with respect to site distribution, bone assemblage composition, and bone damage morphology?
2. What factors determine this behaviour? How are they likely to have affected it in the past? How is an understanding of these effects best applied to the resolution of specific archaeological problems?

An analysis of faunal assemblages associated with northern Plains sites demonstrates a pronounced lack of pronghorn remains. While this has been noted by a number of archaeologists, the implications have yet to be fully explored. In this thesis, four possible interpretations are investigated:

1. As noted in various taphonomic studies, pronghorn may be underrepresented due to the fact that their elements deteriorate more rapidly than bison bones when subjected to chemical and mechanical erosion.
2. The behavior of pronghorn may result in a lack of animals being procured.
3. Butchering practices of the northern Plains hunters may have selectively removed pronghorn bones from the archaeological record.
4. Deliberate conservation of pronghorn may have been practiced, such that, in certain situations, pronghorn were simply not procured.

Pronghorn bone occurs relatively frequently in prehistoric habitation sites in southeastern Alberta and southwestern Saskatchewan and throughout the northern Plains in general, although the number of known localities in which pronghorn procurement was the primary pursuit is limited. While there is little question that the bison was utilized as the primary food source by the various Plains cultures, it was clearly not their only resource. Pronghorn supplemented the diet of the northern Plains people; the question is does the archaeological record accurately portray the realities of the past?

The numerous ecological niches, which existed on the Plains, contained a diverse number of species. To think that the humans inhabiting these areas did not fully exploit the available flora and fauna populations could be considered quite narrow-minded. Historic and ethnographic evidence tells us that although bison were the mainstay of the aboriginal lifeway, "[g]ame, such as that found in the mountains, and antelope [pronghorn], elk [wapiti] and deer naturally ranked second" (Kidd 1937:103). For further proof of this exploitation we only need to look at the faunal remains recovered from the many archaeological sites situated across the prairies. The faunal remains from prehistoric kill sites contain not only bison elements, but those of many other herbivores

as well. These alternative ungulates which are present in the archaeological record include moose, wapiti, caribou, mule deer, white-tailed deer, Rocky Mountain bighorn sheep, mountain goat, and pronghorn.

Given the relative abundance of pronghorn prehistorically the scarcity of their remains in an archaeological context is puzzling and remains largely unexplained. The primary object of this thesis is to provide an overview of pronghorn archaeology, ecology, and physiology as it pertains to hunter-gatherer predation on the northern Plains. This thesis represents the first comprehensive archaeological synthesis of pronghorn faunal data for the northern Plains region.

1.3 Study Area: Natural and Cultural Setting

The northern Plains as defined for this research includes the prehistoric habitat limitations of the pronghorn within Canada. Specifically, this includes the grasslands of Alberta, Saskatchewan and a small area within the southwestern corner of Manitoba. Within context of this thesis the word Plains will refer to the entire Great Plains ecoregion as outlined in Appendix A. In specific cases where a comparison is being made between southeastern Alberta and/or southwestern Saskatchewan and the prairie grassland regions of Montana, Wyoming, North and South Dakota, the Canadian region will be referred to as the northern Plains while the United States region will simply be called the High Plains.

The northern Plains, apart from its mountainous western edge, occupies the extreme northwestern portion of the North American Plains grasslands (see Appendix A) and is characterized by a relatively flat topography and a generally treeless environment. It has low precipitation, low mean annual temperatures and a short growing season

(Christopherson 1997). The Saskatchewan River system is this research area's major drainage basin.

Prior to European contact, the animal most numerous, and most important to aboriginal culture, was the bison (*Bison bison*), a herd animal that weighed up to 800 kg (Arthur 1975). Other fauna included the wapiti (*Cervus elaphus*), deer (*Odocoileus* spp.), pronghorn (*Antilocapra americana*), bear (*Ursus* sp.), wolf (*Canis lupus*), coyote (*Canis latrans*), swift fox (*Vulpes velox*), bobcat (*Lynx rufus*), beaver (*Castor canadensis*), and muskrat (*Ondatra zibethicus*). Subsequent European settlement in the region resulted in the near extinction, or radically altered the distribution of many of these animals. A variety of resident and migratory birds still inhabit the area.

Grasses are the most important floral component of the southern Alberta and Saskatchewan ecozone. Their specific distribution depends on local climate and moisture: xeric grasses have a high frequency in the southeastern part of Alberta and southwestern part of Saskatchewan, with more mesic types found at higher elevations and along the western and northern edges of the Plains (Morgan 1980). The seasonally varying nutritional content of the grasses helped to determine the seasonal movements of the bison (Arthur 1975; Morgan 1980; Peck 2001). Various shrubs and trees such as willow and cottonwood were found along watercourses.

Paleoclimatic research has identified numerous short-term climatic changes in North America during the last 10,000 years (Kay 1998). However, pending specific studies on the northern Plains, descriptions of paleoclimate in the region remain tentative, although there is a high probability that at least some of these episodes can be extended to the northern Plains (Beaudoin 2003). "Over time, the Plains has been biologically dynamic in response to regional climate" (Kay 1998:16). The occurrence of these climatic

changes would have been quantitative, involving alteration to the density and frequency of different grass types and thus the fitness of many of the animals inhabiting the area.

At the time of contact the northern Plains was home to a number of tribal groups. These included the Blackfoot, Assiniboine, Gros Ventres, Kutenai, Shoshoni and Crow (Wilson 1995:376), of which the Blackfoot were the primary occupants of the area covered by this research (Dempsey 1995:403). The exact length of time the Blackfoot occupied southern Alberta is still undetermined (Byrne 1973; Brink 1986), although their occupation certainly extends some distance into prehistory.

The Blackfoot relied on bison for food, clothing, tipi covers, utensils, and many other items, and used procurement strategies such as communal drives to exploit the animals *en masse* (Dempsey 1995:382-383). Dempsey (1995:382) states that "The Blackfoot were interested primarily in the buffalo, calling its flesh *nitapiksisako*, or "real meat," implying that all other meat was inferior". The use of communal hunting techniques lessened, however, as the acquisition of the horse, in the early 1700s, enabled the killing of individual animals by mounted hunters (Dempsey 1995:383-384; Frison 2004:120). Ewers (1968:166-167) recorded the last Blackfoot communal bison hunt, as having taken place in 1874. Although bison was the primary animal resource, other species, such as deer and pronghorn, were taken in smaller numbers, often for specific purposes such as hides for clothing (Wissler 1910; Ewers 1958). These secondary resource species were acquired through the implementation of specific procurement strategies.

1.4 Chapter Summary

Chapter 2 provides an updated overview of pronghorn taxonomy and evolution, distribution, ecology and ethology. In addition, a section on the physical and

morphological characteristics of the pronghorn is included, along with pronghorn reproduction and mortality factors. All of this background information is pertinent to small-scale hunting, specifically pronghorn procurement. This is based on the fact that prehistoric hunters would have utilized the behavioural characteristics of the pronghorn in order to formulate their hunting strategies. This information is also relevant to the archaeologist as an aid in the analysis and interpretation of sites containing pronghorn faunal remains.

Chapter 3 provides an overview of archaeological sites that are significant to northern Plains pronghorn research. This information provides archaeologists with background data from which to compare and contrast future pronghorn procurement sites and eventually draw informed conclusions. In order to accomplish this, a synopsis of published archaeological sites relating to the topic of pronghorn procurement and utilization both on the northern Plains and adjacent regions is included. Every effort was made to include as many unpublished sites as possible. In terms of this research the site data are used to draw conclusions regarding the time depth and seasonality of pronghorn procurement, as well as disclosing the various hunting methods utilized. In addition, these sites are used as baseline data for the purpose of comparison with the recently excavated sites addressed in Chapter 6.

Chapter 4 examines a variety of theories regarding procurement strategies in general and also summarizes current hypotheses regarding the small-scale hunting of pronghorn on the Plains. Chapter 4 also outlines numerous northern Plains hunting strategies developing an argument for small-scale pronghorn procurement within this area. This is accomplished through the examination of pronghorn-specific hunting technology, and ethnographic and historic accounts of pronghorn procurement and utilization. In

addition, the efficiency, and therefore, quantification of small-scale pronghorn procurement is investigated using a modified optimal foraging theory and diet breadth model.

Chapter 5 addresses the apparent scarcity of certain pronghorn elements from archaeological faunal assemblages. Within a broader scope this chapter also examines several possible reasons for the presence of pronghorn remains in habitation sites, yet the apparent lack of kill sites. Also, the various taphonomic factors affecting the presence of pronghorn remains in the archaeological record are outlined. Specifically, the pre-depositional factors of carnivore attrition, weathering and trampling and the cultural activities of primary butchering and secondary processing are described in detail. Finally, bone density as it affects pronghorn bone survivorship is quantified statistically using the paired *t*-test.

Chapter 6 examines two recently excavated archaeological sites (EbPi-75 and DlOu-72) that contain quantities of pronghorn remains. As these sites expand the information database, with regard to pronghorn procurement, their faunal assemblages were catalogued and the data synthesized within this chapter. Procurement patterns are discussed and comparisons are drawn between similar sites as they relate to the pronghorn as a secondary faunal resource on the northern Plains.

Chapter 7 summarizes the previous chapters and a variety of conclusions are presented concerning the small-scale procurement of the northern Plains pronghorn. In addition, suggestions for future archaeological research pertaining to the pronghorn are presented.

It is the intent of this thesis to establish a case for small-scale pronghorn procurement on the northern Plains. As stated above, this is to be accomplished through

the examination of past archeological, ethnographic and historical work. In addition, two recently excavated sites will be analyzed for possible association with this procurement strategy. An explanation for the lack of known pronghorn procurement and small-scale hunting evidence will also be sought, using the correlation between bone density and the lack of an archeological signature as one hypothesis.

CHAPTER TWO

An Introduction to the Pronghorn

2.1 Chapter Introduction

Pronghorn behaviour is an important variable in the interpretation of prehistoric procurement strategies. Both biological and environmental conditions determine the pronghorn's behaviour. The former include sex, age, herd structure, and condition of the animals; the latter include season, weather, availability of food, terrain and vegetative cover. In order to accurately interpret past pronghorn procurement strategies the archaeologist has to be familiar with pronghorn behaviour.

For example, given a better understanding of climate-ungulate ecological models, archaeologists will be able to anticipate the underlying conditions that account for variation in site location, size and structure, duration of use, and content in and around the selected habitat regions of the pronghorn (Osborn 2003). In this regard, Frison (1991b:28) has observed: "Archaeologists too often are reluctant to utilize animal behaviour studies or the direct experiences of hunting for analyzing past hunting methods and the limitations imposed by prey species."

The perspective adopted here is that animal species demonstrate separate and distinct behaviour patterns that are reflected in procurement methods and therefore the archaeological record. The following review of the pronghorn is included so that an understanding of size, herding behaviour, habitat and any other characteristic that might

have been noted or taken advantage of by aboriginal hunters during the procurement of this animal may be understood. These unique traits and behaviours can then be used to better understand the pronghorn from the viewpoint of northern Plains hunters as they would have known this prey species.

2.2 Taxonomy and Evolution

2.2.1 Nomenclature

At present the pronghorn (*Antilocapra americana* [Ord 1818]) is generally classified as being the only remaining member of the unique family taxon called Antilocapridae, belonging to the order Artiodactyla. Although there has been some debate as to whether or not the pronghorn is actually a distant relative of the Old World Antilocaprin Bovids (O'Gara 1982; O'Gara and Matson 1975) all recent systemic studies have retained the family Antilocapridae, and most have concluded that this family is closely related to the Cervidae (Byers 1997, 2003b). Classification of the pronghorn is based primarily on the annual shedding of horn sheaths. Murie (1870) provides a detailed account of early debate on the taxonomy of pronghorn.

The pronghorn's scientific name, *Antilocapra americana*, means "American antelope goat." More specifically, Anthalops (Greek) a horned animal [probably from *anthos* (Greek) a flower and *ops* (Greek) the eye which refers to the beautiful eyes of antelope]; *capra* (Latin) a she-goat; *anus* (Latin) suffix meaning belonging to.

Common names include pronghorn, antelope, prong buck, prairie antelope, American antelope, prong-horned antilope, Forcifer antelope, berrendos (Mexican), goat, jumping deer, and cabrie (French-Canadian). Meyer and Russell (2004:238) note the Plains Cree word *apistacihkos*, meaning small caribou, with reference to the

pronghorn. The Sioux name *tah-keen-cha sanal*, for the pronghorn means "little pale deer" (McCabe et al. 2004:145; Seton 1953). In addition Hudson's Bay Company employee Anthony Henday (Belyea 2000:97, 99) is noted referring to pronghorn as "wild goats" (see also Meyer and Russell 2004:238). Frison (1991a:239, 2004:121) makes mention of people "commonly" calling the pronghorn "stinking goats". He indicates that this reference is associated with either "the careless hunter who gut-shoots the animal or in field dressing allows the contents of the paunch to contaminate the meat" (Frison 1991a:239) or "the timing of current hunting seasons" (Frison 2004:122). In fact, the odor of a pronghorn is no more objectionable than that of bison, elk, or deer, and the pronghorn is not a close relative of the goat (Frison 1991a:239).

Although still commonly referred to as 'antelope' in North America, authors of contemporary technical literature use the descriptor "pronghorn" in recognition of the animal's unique horns and to differentiate the North American species from the antelope of Asia and Africa (Lubinski and Herren 2000). Throughout this thesis the author has chosen to adhere to scientific protocol and use the word pronghorn in reference to this North American Plains mammal. The only exception to this will be in cases where the term antelope was used by another author in a quoted segment of text or within an archaeological site name.

Today, there are five recognized races (subspecies) of pronghorns in North America. One common, American pronghorn (*A.a. americana*), and four subspecies Sonoran pronghorn (*A.a. sonoriensis*), Chihuahuan pronghorn (*A.a. mexicana*), Oregon pronghorn (*A.a. oregona*) and Peninsular pronghorn (*A.a. peninsularis*) are named (Paradiso and Nowak 1971; Yoakum 1978; Hall 1981). Currently there is little evidence

that the degree of difference among subspecies is greater than that among geographically isolated populations (Lee, Jr. et al. 1994).

In general, the subspecies differ from the typical form and from one another only in comparatively slight details of size, color, and anatomy. Although the pronghorn may show slight local variation in the attributes mentioned above, the roles of genetic versus environmental effects in producing these differences are not known (Byers 2003b).

2.2.2 Evolutionary Perspective

Whatever the lineage, the pronghorn represents an indigenous component of the large-mammal fauna of North America, having evolved from ancestral forms that originated on the continent. The subfamily dates from the Miocene in North America, the genus from the middle Pliocene, and the species from early Pleistocene (Kitchen and O'Gara 1982:960).

Fossil records imply that one of the earliest ancestral forms of the present day pronghorn, *Merycodus*, appeared in North America some 25 million years ago (Geist 1988; Mitchell 1980; Romer 1966). Throughout the epochs following the Miocene a variety of intermediate species evolved only to eventually become extinct (Mitchell 1980). These early ancestors of the pronghorn evolved following a series of upheavals involving the earth's crust. These geological events produced the Rocky Mountain Cordillera, and subsequently had a profound influence on the climate of North America. The trend toward a cooler and more arid climate, particularly in the mid-continental region, was an important factor in the development of the vast prairies, as former expanses of subtropical forests were replaced by grasses, broad-leaved plants, and

shrubs. This Great Plains grassland environment is the preferred habitat of the pronghorn and its early ancestors (see Appendix A).

The family Antilocapridae comprises two subfamilies: the small-bodied Merycodontinae (middle to late Miocene) and the larger Antilocaprinae (end of Miocene to present) (Byers 1997; Janis 2000; Walker 2000; Webb 1973). Antilocaprinae is thought to have evolved from and then quickly replaced the Merycodontinae (Byers 1997, 2003b; Janis 2000). The genus *Antilocapra* dates from the middle Pliocene (Webb 1973); however, the exact origin of the species is uncertain.

Based on the geological contexts of fossil specimens, it has been estimated that several genera of antilocaprids have existed in North America from the middle Eocene (ca. 13 million years B.P.) into the mid or late Pliocene epoch (Einarsen 1948). They occupied the temperate grassland prairies and shrub steppes west of the Mississippi River Further fossil evidence suggests that additional unique genera were present during the Pleistocene (Yoakum 1978:103; Kitchen and O'Gara 1982:960; Walker 2000), and that the present population is the sole survivor of the family, Antilocapridae (Byers 1997:13). As recent as 11,000 years ago there were four genera of pronghorns. Besides *Antilocapra* (two-horned) and *Tetrameryx* (four-horned), there were two other four-horned species *Capromeryx* and *Stockoceros* (Geist 1988; Janis 2000; Walker 2000). With the exception of *Antilocapra* these species died out during the Pleistocene epoch (Walker 2000; McCabe et al. 2004).

At the advent of the Pleistocene, about 1 million years ago, a series of ice sheets and glaciers advanced southward from the polar ice cap (Mitchell 1980). These events spelled the demise of 40 of the 47 species of North America's herbivores (Geist

1988:203). The six surviving species were the musk ox, Rocky Mountain bighorn sheep, mountain goat, pronghorn, white-tailed and black-tailed deer, and bison. Following the Pleistocene, which was the beginning of a period of crisis and change for both plants and animals on the Plains, came a new wave of fauna. This new group included of a mixture of Siberian immigrants, plus a few surviving species from the old American fauna (Geist 2000; Martin and Guilday 1967). These survivors are opportunists, "species that avoid competition, that live by dispersal and quick exploitation of whatever opportunities there are to reproduce, and that fit into "ecological cracks" between the specialists" (Geist 1988:203). While the above mentioned opportunists survived; none of the Pleistocene specialists did (Martin and Guilday 1967:129). The pronghorn, as we know it today, survived these climatic crises and stresses and flourished to become one of the major hoofed mammals of the Great Plains region.

For over 4 million years, the pronghorn has coexisted with predators on the open plains of North America (Byers 1997). It has evolved in a habitat that offers long fields of vision, often in every direction, and it has survived not by hiding from its predators but by outrunning them. In turn the predators, which consisted of plundering dogs, coyotes, wolves, dire wolves, dholes, protocyon, giant short-faced bears, saber-toothed cats, North American lion, American cheetahs, jaguar, cougar, cheetah and the hyena, have had to come close to matching its running performance or resort to pack-hunting or ambush tactics (Byers 1997:9-12). In the "arms race" for speed and endurance that has been waged for millions of years, the slowest pronghorn in many a chase got eaten. Weaknesses were exposed and culled out of the gene pool. Byers (1997:12) states that at the present time, "pronghorn are ridiculously too fast for any modern predator," and

their running prowess is a "ghost" of that previous selective pressure that was greatly relaxed approximately ten thousand years ago after the late Pleistocene extinctions that decimated the North American fauna. These extinctions constituted a nearly complete relaxation of predation-based selection on pronghorn adults (Byers 1997). Following the Pleistocene extinctions the adult pronghorn surely was shocked by the appearance of a new form of predator, the aboriginal hunter. The pronghorn was hunted by prehistoric inhabitants of the Plains region for at least 10,000 years, however, the importance of the pronghorn as an economic resource has varied over time and from place to place within this region (Pastor et al. 2000:1).

2.2.3 Historical Perspective

Just how many pronghorn roamed North America prior to the arrival of the Europeans is not known for sure, however, the pre-European pronghorn population has been estimated at between 30 and 40 million animals (Yoakum 1978:113). Recently, numerous wildlife biologists view this estimate as an extremely conservative one, and maintain that 60 to 80 million animals is a more reasonable estimate for the prehistoric population of western North America (Arkush 1995:12). In fact, in some regions pronghorn numbers would have surpassed those of the bison (McCabe et al. 2004).

When Lewis and Clark first ventured across the North American prairies in 1803-1806, they observed vast herds of pronghorn (Glasgow 1990) and remarked that these small speedy ungulates reminded the explorers of Old World gazelles; consequently, the explorers called them antelope (Yoakum and O'Gara 2000). It was from the first specimens that Lewis and Clark collected in 1804 that George Ord (1818) described and

assigned the pronghorn its scientific name, (*Antilocapra americana*) (Yoakum 1978:103).

Specific to the northern Plains, Hudson Bay Company employee Matthew Cocking observed the pronghorn during his 1772 travels in Saskatchewan (Meyer and Russell 2004:238). He noted the pronghorn as "of the same kind as the other [deer] but something less in size and differing in Colour being of a reddish brown except the Belly and inner part of the thighs, which are of dirty white" (Meyer and Russell 2004:238). In addition, Meyer and Russell (2004:238) state that Anthony Henday makes note of hunting the pronghorn during his travels across central Saskatchewan. "For instance, on October 6, 1754 [Henday] wrote: "Two young men brought in 3 Goats: they are not so large as the Welsh ones" (Belyea 2000:99).

Pronghorns were plentiful in the west in the early nineteenth century and occupied a much larger range than they do today (Figure 2.1). However, early settlers who plowed the native grasslands destroyed much of the prime pronghorn habitat. By the later part of the century, numbers declined at an alarming rate. In fact, continental populations were reduced to less than 1 % of their pre-European numbers (Yoakum and O'Gara 2000:560).

Modern population estimates for Canadian pronghorn followed a similar pattern of decline as in the United States. From a low of 1300 animals, in 1924, to 22,300 in 1989, a remarkable increase of 1600 %, the pronghorn population is slowly making a comeback (Yoakum 1978; Yoakum and O'Gara 2000). Currently, "about 1 million pronghorn are scattered across 15 U.S. states, 2 Canadian provinces, and 4 Mexican

states. However, about one half of the North American pronghorn occur in Wyoming" (Byers 2003b:998).

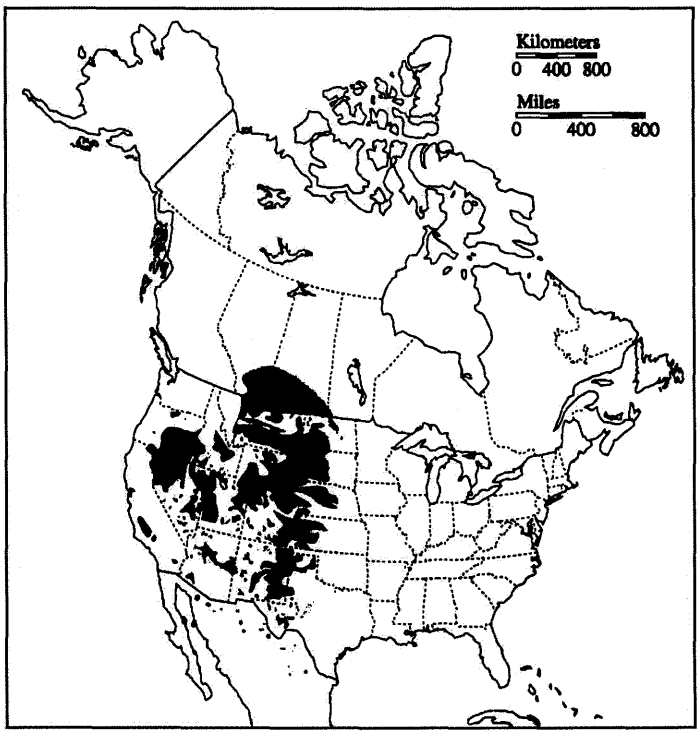


Figure 2.1 Modern range distribution of the pronghorn (Adapted from Byers 2003b:998).

2.3 Distribution: Past and Present

2.3.1 North American Distribution

The historic range of the pronghorn extended north beyond the South Saskatchewan River in Saskatchewan, and the Red Deer River in Alberta, and included southwestern Manitoba; southward through Chihuahua, and Coahuila to northeastern Durango, Mexico; the desert plains of central and western Sonora, to approximately 29° N on the west coast; eastward to western Minnesota, western Iowa, northwestern Missouri, Kansas, Oklahoma, and western Texas; and westward to western Montana, southern

Idaho, eastern Oregon, Nevada, and California (Kitchen and O'Gara 1982:960). Pronghorn still occupy shrub and grassland habitat through much of their former range. In Canada pronghorn inhabit the open grassland ecosystem which encompasses the Short Grass, Mixed Grass, Fescue Grass and Aspen Parkland ecoregions (see Appendix A).

Today free-ranging pronghorns found in Alberta and Saskatchewan, in 17 western states of the United States, and in northern Mexico. In addition, numerous pronghorn were captured and released in 1959 on the island of Lanai, Hawaii, as well as locations in Florida and Washington. All of these stocking efforts outside of ancestral habitats failed to establish sustaining populations for more than several decades (Yoakum 1978; Popowski and Pyle 1982; Yoakum and O'Gara 2000).

2.3.2 Canadian Distribution

The northern boundary of the pronghorn range historically matched closely the termination of prairie and beginning of parkland transition zone (McCabe et al. 2004). In Canada pronghorn were present from the Red River in Manitoba to the foothills in Alberta and north to Edmonton (Geist 1988:210). The pronghorn in Saskatchewan ranged as far north as 53° N, in the vicinity of Carlton House, and eastward to the plains of southwestern Manitoba (Mitchell 1980; Seton 1953:417). This is a distance of just over 486 air kilometers north of the Montana-Saskatchewan border. That far north the population must have been very sparse, or only seasonally present, as winter temperatures can occasionally dip below minus 50° F.

Today, the majority of Saskatchewan pronghorn are confined to the southwest portion of the province. This region is semi-arid with low annual precipitation, high

evaporation, prolonged periods of drought, and great extremes in temperatures between seasons (Wiltse 1978:163). Their range is divided roughly into five areas that are characterized by different vegetation.

The Frenchman River drainage system occupies some 3219 square kilometres (2000 square miles), much of which remains native prairie. The walls of the valley often provide shrubs for pronghorns throughout the winter and the river is a reliable source of water during the summer. Pronghorns throughout this area rely on adjacent uplands during the hot summers for much of their forb needs.

Along the border with Montana lies one of the largest pronghorn ranges in the province. The Govenlock area, once thought of as the pronghorn capital of Canada, marks the westward extension of the southern range. It is generally flat, open land, with abundant sagebrush, ideal pronghorn habitat (Sundstrom et al. 1973).

The Cypress Hills area of Saskatchewan stretches into Alberta and covers a third of the remaining pronghorn range in this province. The Cypress Hills are eroded benchlands, consisting of elevated plateaus dissected by valleys and coulees. Level to gently rolling plateau areas occur on the higher elevations, which extend to 1341 m above sea level (Dirschl 1963:85). Moderately rolling topography occurs on the lower elevations. Pronghorn populations were never large in the upper reaches of this area, but they do tend to occupy areas that are on the lower topographic elevations. Winters are milder in the hill country but the quantity of snow that falls is far greater than the provincial average. During the winter warm winds called "chinooks" blow in, and in a matter of hours the high points of this region can be swept clear of snow and ice. Sometimes within three hours, the air temperature can change by as much as 40 degrees.

This kind of weather has allowed the pronghorn to survive. The highly diversified vegetation of the region offers the pronghorn greater choice in food selection (Dirschl 1963:84).

The final area of significant pronghorn habitat in the province of Saskatchewan is the Great Sand Hills range, which occupies approximately 810 km². The many open dunes alternating with ridges of low rolling hills, provide the pronghorn with forage as well as cover.

The most northern range of the pronghorn was found in the province of Alberta (Wishart 1970). Pronghorn currently extend north into the parkland ecozone and west to the eastern edge of the foothills. The southeastern part of their range holds the greatest population of pronghorns.

While Alberta's potential pronghorn habitat covers approximately 64,000 km², in reality pronghorn herds regularly inhabit approximately 22,680 km² in the southeastern corner of the province. Within this area the pronghorn are concentrated in the short and mixed-grass prairie biogeographical zones, which are considered to be optimal habitat (McCabe et al. 2004). Here, sagebrush and pasture sage are the major components of the winter diet, accounting for as much as 70 % of the plants consumed. Under favorable moisture conditions Alberta's rangelands are some of the most productive in the world, and in good years pronghorn populations flourish, with fawn-to-doe ratios as high as 88 fawns per 100 does. In dry years the number of births declines to as low as 54 fawns per 100 does in some areas (Popowski and Pyle 1982:114).

2.4 Physical Description

2.4.1 Skin and Pelage

Pronghorn are striking in appearance (Figure 2.2), with an overall body colour ranging from dark tan to pale sandy-brown according to habitat, season, sex, and age. The white throat is distinctively traversed by three tan-coloured bands along the sides of the neck as well as a sharply contrasting pattern of white banding on the head.

Colour markings on the head are different in males and females. Mature bucks have a blackish band running along the top of the snout from the nosepad to the forehead, and a dark triangular cheek patch below each ear. Mature females show no black cheek patches, and the snout colour is lighter and less contrasting to the white of the cheeks than in the males. The pronghorn's belly and lower sides are creamy white and their relatively thin legs are light tan in colour. This camouflaged colouring enables them to blend into the open grassland-savanna ecozone that they have occupied since the Pleistocene epoch.

Figure 2.2 Female pronghorn showing distinctive markings

Mature pronghorns also have a short, blackish-brown, erectile mane, approximately 7-10 cm long, running along the dorsal midline of the neck (Kitchen and O'Gara 1982:961). The short tail is surrounded by a patch of long white hairs, which are also erected when the animal is alarmed (Byers 2003b:998).

As mentioned above, the pronghorn use their hair as an alarm signal. The rump patch consists of long hairs that can be raised into a conspicuous white rosette when the animal is alarmed. The muscles associated with each follicle in the rump contract and cause the hairs to erect and also force secretory material from a gland located in the rump. The rump patch, then, appears to serve as both a visual and an olfactory intercommunication system between pronghorns.

The fawns are not spotted like deer fawns, but have a pattern similar to adults. However, newborn fawns are lighter in colour and more grey than their parents; white areas are stained with buff and blackish parts are faintly indicated. Fawns molt their drab-coloured coats at about three weeks of age, acquiring adult colours (Bromley 1977). Whorls of dusky hair mark the location of developing horns.

The skin of the pronghorn is covered with longer brittle outer hairs and a much finer underfur. The outer hairs have large internal air cells and are shed throughout the year (Popowski and Pyle 1982:5). In fact, the stalks of the long winter hairs are longer and thicker due to an increase in internal air space over the summer hairs (Kitchen and O'Gara 1982:961). During extreme weather conditions, this combination of hollow hair and woolly underfur provides excellent insulation. However, even with excellent cold weather insulation severe winters represent a significant cause of mortality in pronghorn populations (Barrett 1978, 1982). Although pronghorn often use snow for additional

insulation, deaths have been attributed to freezing storms that produced deep snow and ice that impeded travel and reduced forage availability (Barrett 1982; Bruns 1977).

2.4.2 Skull Morphology

Pronghorn have remained essentially unchanged through time as far as biological and morphometric characteristics are concerned (Frison 1987, 2004; Janis 2000; Sanders and Miller 2004). Therefore, the modern pronghorn skeleton can be quite useful for comparative purposes due to the fact that the elements are quite similar in size, within 3 to 8 % (Adams et al. 1999:289), to their prehistoric counterparts.

The pronghorn skull in particular has a number of unique adaptations and characteristics (Figure 2.3). The frontal sinuses of pronghorn skulls open to the outside

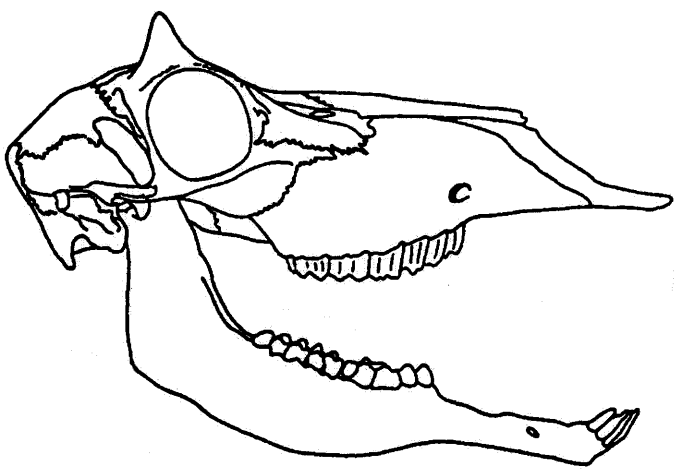


Figure 2.3 Lateral view of pronghorn skull (Adapted from Mitchell 1980:58)

via two large, longitudinal fossae in the dorsal surface of the frontal bones (Figure 2.4). The lacrimal bones do not articulate with the nasal bones (Hall and Kelson 1959). Suborbital depressions are not present and the supraorbital foramina are large. The nasal bones are bifurcate and widest posteriorly. The messeteric ridge is low and the auditory

bullae are moderate, compressed, and angular (Figure 2.5). Horn cores in males, and when present in females, are directly superior to the orbits, which are very large and slightly elevated above the face. The brain is located in the posterior one-third of the skull and the nose is elongated.

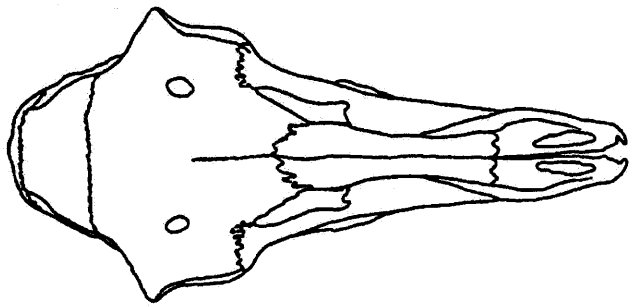


Figure 2.4 Dorsal view of pronghorn skull (Adapted from Mitchell 1980:58)

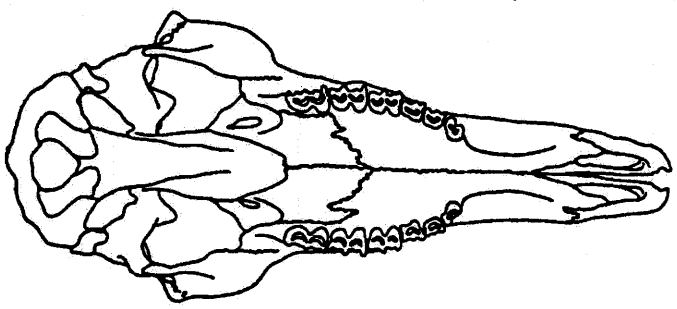


Figure 2.5 Ventral view of pronghorn skull (Adapted from Mitchell 1980:58)

The pronghorn's orbits are large and resemble turrets, in addition the skull has a strong postorbital bar. The top of each orbit is dorsal to the skull roof. The turreted orbits, placed high and far back in the skull, allow the pronghorn an excellent field of vision. In fact, they are able to see almost directly to the rear when the head is up and far to the side and when the head is lowered (Byers 2003b:999).

The pronghorn's large eyes, averaging 5 cm in adults, are set in protruding bone-rimmed orbits and provide the pronghorn with keen eyesight. They can see an object 4-7 km (3-4 mi) away (Banfield 1974:402), however ignore stationary objects unless they arouse their curiosity. Their eyesight is reported to be comparable to humans using 6x or 8x binoculars (Popowski and Pyle 1982; Glasgow 1990).

Their hearing and sense of smell are also fairly keen (Banfield 1974). In fact, this set of acute senses provides the pronghorn with excellent advance warning of any nearby predators.

In addition to the above outlined information, Mitchell (1980) provides a detailed account of craniometric characteristics and variations as they pertain to the pronghorn skull.

2.4.3 Horns

The horns of the pronghorn consist of "a bony horn core that grows from the frontal bone and is not shed, however, the keratinized sheath covering the horn core is shed annually" (Reitz and Wing 1999:66). (Figure 2.6). Pronghorn horns are not agglutinated hair-horns as commonly reported in the literature (Kitchen and O'Gara 1982; O'Gara and Matson 1975). However, hair is incorporated into the rapidly growing horns near the bases, similar to those of bovids (Kitchen and O'Gara 1982:962).

Like the horns of bovids, those of pronghorns consist of a keratinous integumentary sheath surrounding a horn core of bone (Byers 2003b:999). Solounias (1988) showed that the bladelike core of pronghorn develops as a direct outgrowth of the frontal bone, as do the antler pedicels of deer. In contrast, horn cores of bovids arise by the fusion of

outgrowths of the frontal bones with dermal centers of ossification (the ossa cornua). This is compelling evidence that pronghorn belong in the superfamily Cervoidea (Byers 2003b). The family Antilocapridae stands between the Cervidae, with their deciduous antlers, and the Bovidae, with their permanent horns (Banfield 1974).

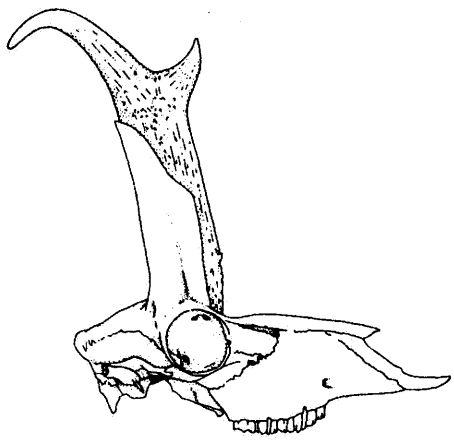


Figure 2.6 Male pronghorn skull showing placement of horns (Byers 2003b:1000)

The pronghorn's true horns are long and oval at the base and circular at the tips. The tips normally bend inward toward each other and bifurcate at approximately the mid-point to form a prominent "prong", hence the name "Pronghorn". As stated above, the horn sheaths are unique in that they are shed annually in October-November, exposing the beginnings of a new sheath already in the process of development (O'Gara and Matson 1975). In Alberta, horn-casting commences in late October (Mitchell 1980:68).

Subsequent rapid growth of new horn sheaths occurs during the winter and spring. By the beginning of breeding season mature bucks can grow horns that exceed 51 cm in length (Banfield 1974). However, males generally have horns that are 25-40 cm in

length (Byers 2003b; Kitchen and O'Gara 1982; Yoakum and O'Gara 2000). Mature does, however, are either hornless or have horns that are small and inconspicuous (Mitchell 1980:67).

Pronghorn horns represent an ideal compromise between non-shedable horns and antlers. Their horns minimize the cost of transportation (are lightweight), avoid mineral and protein cost, and allow for seasonal repair. Horn damage in the pronghorn rut is often substantial (Byers 1997:178-179). After the rut, pronghorn males simply discard these used sheaths and simply grow new ones, without incurring the large mineral and protein costs typical of cervid antler growth. Another advantage of horn sheath shedding is that males, often exhausted by rut activity, are able to join and be fairly inconspicuous within a mixed-sex herd (Geist and Bromley 1978).

2.4.4 Appendicular Skeleton

The pronghorn skeleton is not necessarily lighter than what would be predicted for a hoofed mammal that weighs approximately 55 kg, however, the bones, especially the limb bones are long, slender, lightweight, and delicate looking. As noted by Murie (1870:353), "...these [bones] are remarkable for their lightness and porosity throughout the whole skeleton; indeed,...no ruminant skeleton of equal size possesses such delicacy of osseus texture....If one were to speculate on this fact it might be given as one reason for the extraordinary fleetness of the creature." This sentiment is echoed by Byers (2003a), who observed that the pronghorn has a "honeycombed, ultralight bone structure" complete with long, very slender and lightweight lower limb bones. However, the "...antelope possess such a vitality that it takes more to kill them than their fragile appearance might indicate" (Popowski and Pyle 1982:293).

In fact, the unique and specialized bone structure is one of the adaptations that allows the pronghorn to run fast, as well as far. Pronghorn are designed for endurance as well as speed. This dual design is remarkable, because a design for speed often conflicts with a design for endurance. Some of these specialized bony elements include the metacarpal, which, in the front limb of an adult pronghorn is approximately 23 cm (9 in) long and just slightly thicker than a human index finger. The ulna is a thin, but complete, splint. The fibula is a thin, incomplete splint. The cannon bone of the carpus is as long as the radius, and in the case of the tarsus it is only about 3 cm shorter than the tibia. In the tarsus, the cuboid and navicular are fused, as are the ectocuneiform and middle cuneiform (Byers 2003b:999).

Neither cannon bone shows any trace of lateral digits or "dew claws". While this makes the pronghorn slightly lighter it also has some negative consequences. Based on the fact that "pronghorns do not have dew claws [they] are not as mobile on soft ground or deep snow as other ungulates" (Glasgow 1990:2). This unique characteristic of the pronghorn can aid a hunter in track identification, especially if the ground is soft enough for the feet to sink in a short distance (Frison 1991a). The pronghorn's pointed hoofs are cloven and black with cartilaginous padding to cushion the impact of running on hard, irregular surfaces. The front hoofs are slightly larger than the rear ones and seem to carry most of the animal's weight when it is running.

2.5 Physiology

2.5.1 Pronghorn Adaptations

The pronghorn is well adapted to its open, arid environment. Physiologic characteristics and adaptations such as selective cooling of the brain during heat stress,

large respiratory organs and airways, high buffering capacity and hemoglobin levels of the blood, and high blood volumes are not visible (Lindstedt et al. 1991;Yoakum and O'Gara 2000). However, these attributes complement the pronghorn's long legs and heavy proximal muscles and lightweight feet resulting in a swift and enduring runner (Hildebrand and Hurley 1985). Physiologic adaptations to help the animals cope with semiarid environments include conserving water through countercurrent exchange of respiratory air in the long nose and lowering urine output by reducing food intake during periods of dehydration (Bromley 1977; Whisler 1984). These physiologic adaptations combine with behaviour to make pronghorns extraordinarily unique animals (Yoakum and O'Gara 2000).

2.5.2 Body Mass and Dimensions

The pronghorn is small when compared to deer, elk or bison, in fact, they are the smallest big game ruminant in North America. They have a gracile build, are relatively lightweight for their size, and sexual dimorphism in body mass is slight (Byers 2003b:999). In Alberta, mean body masses of males and females averaged 56.4 kg (range 46.5 to 70.3) and 50.5 kg (range 46.9 to 56.2), respectively (Mitchell and Smoliak 1971; Mitchell 1980). The body weight of pronghorn at the northern limit of their range is dependent on nutritional factors and season of the year, and therefore varies seasonally. Northern fawns weigh from 2.3 to 3.2 kg (5 to 7 pounds) at birth (Fairbanks 1993; Yoakum 1978).

The evolutionary process has kept the pronghorn light for speed and endurance by minimizing most organs: the skin is paper thin, the hair is hollow, the bones are thin-walled and full of cavities, the horns are light, the skull is pneumatic, and fat deposits are

kept low (Geist 1988). Bucks do not deposit a large load of fat before rutting as do deer, moose, elk, caribou, bighorn sheep, or mountain goats. In contrast, the pronghorn gestation period (250 days) is elongated so as to place a portion of the costly reproductive activities into summer and early fall. This allows pronghorn bucks to convert food directly into the work required to establish and guard mating territories, making fattening unnecessary (Geist 1988:207). The pronghorn also reduces food intake, for in fattening, every food calorie stored as fat results in one food calorie being lost as heat. Consequently, fattening requires a greater food intake and would force pronghorns to carry about larger, heavier bellies, and to get rid of more metabolic heat. That would be difficult for pronghorns exerting their bodies while running from predators on hot summer days. To succeed in such life and death races, pronghorns have to run light and cool in summer (Geist 1988:207-208).

In the northern parts of the pronghorn's range, bucks are heaviest during late summer (Mitchell and Smoliak 1971). They gradually lose this fitness during the strenuous fall period leading up to and during the rut. At the end of the rut, generally by the early October, male Montana pronghorns have little fat left (Byers 1997:204). The same is true for Colorado bucks, which stored little fat until after breeding season (Bear 1971). This results in northern male pronghorns being in slightly better condition than southern pronghorn during pre-rut, depleted from the stresses of the rut by the end, and actually building up a store of fat during the winter months. This build-up of fat is only possible if the weather cooperates; if it does not, winter deaths among males can be high.

The stresses of parturition and lactation keep does thin until autumn; maximum weights are reached in November and December in Montana and Colorado (Bear 1971;

Byers and Hogg 1995). "Adult females enter winter with greater fat stores than fawns and adult males and consequently have the greatest resistance to prolonged nutritional stress" (Barrett 1982:999). In Alberta, mean body masses of males and females in late fall were 52 and 47 kg, respectively (Mitchell 1980). Kidney and visceral fat reserves are highest in early winter and declined progressively with prolonged winter severity. However, no seasonal trends in femoral fat levels were found in pronghorns collected in Colorado by Bear (1971:586) and few specimens had less than 70 % fat. Both sexes were generally thinnest during May in the north (Bear 1971).

Adult pronghorn shoulder heights range from 87.3 to 94.8 cm in males and 83.0 to 91.4 cm in females (Mitchell 1980). There is some evidence that northern pronghorns have larger body weights, shorter ears, and are not as high at the shoulder compared with pronghorns on desert ranges in Texas and Mexico (Mitchell 1980).

2.5.3 Aerobic Capacity

Pronghorns open their mouths and gulp air as soon as they start to run. They have large trachea, allowing rapid exchange of oxygen (Kitchen and O'Gara 1982:963). When in flight, bucks normally run with their noses pointed towards the ground while does tend to hold their heads high.

Pronghorns and domestic goats are similar-sized ruminants that may be distantly related. However, relative to body size the pronghorn has a larger windpipe, heart, and lungs, than a goat, which in turn allows them to take in larger quantities of air when running. In fact, a pronghorn has approximately 3 times the lung volume of a goat, greater gas diffusion capacity through lung tissue, an oversized heart, more cardiac output, greater hemoglobin concentration in the blood, more lean muscle mass, and

greater numbers of mitochondria resulting in more oxidative enzymes in the muscles. Maximum oxygen uptake is roughly 5 times higher in pronghorns than in goats (Lindstedt et al. 1991:749). Pronghorn also regulate their muscle temperature 2.6 °C higher than do goats (Lindstedt et al. 1991:749). As running speed is a function of body temperature, such a temperature difference alone should result in a 35 % greater metabolic rate. All of these adaptations allow the pronghorn to easily out run even the quickest goat.

In addition, the pronghorn's maximum aerobic capacity (VO_2 max) is 3 times greater than predicted for their approximately 32 kg (71 lbs) body mass (Lindstedt et al. 1991:749). This deviation from the predicted is called adaptive deviation, and the huge deviation (approximately 300 %) in the pronghorn's predicted VO_2 max indicates that these animals indeed have adapted an unique athletic prowess with respect to aerobic specialization (Heinrich 2001).

The pronghorns' unique running capacity is achieved by the evolutionary enhancement of a specific suite of many of their normal mammalian features. There are no tricks or magic. No one adaptation by itself makes the difference. Pronghorns are just better at everything that affects sustained running speed.

2.6 Ecology

2.6.1 Habitat Characteristics

As previously noted, pronghorn evolved in the late Tertiary Savannah of North America, and therefore show many adaptations for living in open grassland. Pronghorn prefer open country with unrestricted direction of travel and lines of sight. They are

selective browsers, adapted to exploit the diverse and patchy mosaic of grasses and forbs created by bison (Krueger 1986) and other large, and now extinct, grassland grazers.

Based on several studies conducted over the years, the species prefers habitat with: 1) ground cover averaging 50% living vegetation and 50% nonliving vegetation, 2) a vegetation composition of 40-60% grass, 10-30% forbs and 5-20% browse, 3) succulent plants, available in spring and wet summers, and 4) vegetation averaging 38 cm (15 in) in height (Yoakum 1978). In fact, management guidelines typically describe acceptable pronghorn habitat as open terrain with at least 50% plant cover (mixture of native grasses, forbs, and shrubs), and the availability of winter range where snow depth does not prevent foraging or free movement (Byers 2003b). The carrying capacity of the various summer and winter ranges are in part governed by food preferences, nutritional requirements, and food availability, particularly during the critical winter season (Dirschl 1963:82).

Across North America pronghorn utilize 26 different prairie and shrubland habitats within their range (Sundstrom et al. 1973). Although specific plant species vary with region, certain characteristics are common to habitats with high pronghorn populations. These include a low, rolling topography, a mixture of forage types (i.e., forbs, grasses, and shrubs), and an annual precipitation of 25-35 cm (Yoakum 1974). The best habitats are those that provide water and an abundance of low-growing, high-quality vegetation.

The specific forage requirements for the presence and reproduction of pronghorns are: a strong forb component (25-35 % of composition), high-quality winter browse that is above snow level (10-20 % by composition), a mixture of native grasses; and at least 50 % ground cover of plants (Stephenson et al. 1985; Sundstrom et al. 1973)

The present distribution of pronghorn population by habitat shows that 67 % (N = 390,000 animals) occurs in various shortgrass to midgrass habitats, 32 % occurs in mixed grass-shrub habitats, and 1 % in deserts (Kitchen and O'Gara 1982:964). The grassland habitats contain the best mixed-vegetative conditions and consequently receive the highest use by pronghorns.

Pronghorn are present in highest densities on native rangelands in Alberta, Saskatchewan, Montana, North Dakota, South Dakota, and Wyoming. These regions support approximately 80% of the modern continental population of pronghorn. One common denominator in this abundance pattern is the presence and heavy use of sagebrush (*Artemisia* spp.) by pronghorn (Mitchell and Smoliak 1971; Sundstrom et al. 1973; Wiltse 1978). The optimum pronghorn range is that which provides a variety of sagebrush species and broad-leaved plants (Barrett 1980). Although grasses are usually present on this optimum range they are eaten sparingly and are most important in the pronghorn's diet in early spring, when newly emerging shoots are the only green and succulent vegetation available.

2.6.2 Nutrient Requirements

The pronghorn, as heavy as a domestic sheep, eats daily only half as much food (Sundstrom et al. 1973) due to its small gut, about one-half as large as that of a domestic sheep (Kitchen and O'Gara 1982:963). In fact, the heart, lungs, liver, and kidneys are all larger than those of sheep (Sundstrom et al. 1973). The small stomach necessitates the use of nutritious, high-protein forage, but is an advantage to the fast-running pronghorn, as are the large heart and lungs. Pronghorn feed mainly on more nutritious, though often poisonous, dicotyledonous plants, which protect themselves against being eaten with

various toxins and salts in their leaves and bark. To detoxify forage, the pronghorn feeds on small portions of each species and processes the toxins through its large liver and kidneys (Geist 1988:206). The liver also must provide a ready source of energy in the form of stored glycogen and may aid the pronghorn in using plants higher in selenium, alkaloids, and essential oils than bison can. The pronghorn's large kidneys may also be an adaptation to conserve water in desert areas, but primarily they allow greater excretion of toxic substances from plants (Kitchen and O'Gara 1982:963). During the drier seasons pronghorn are often bound to free-standing water, because they need ample water daily to metabolize the excesses in secondary plant compounds.

When the moisture content in vegetation consumed is adequate, pronghorn may consume little to no water (Beale and Smith 1970). However, during hot, dry weather, when plant moisture content declines, pronghorn will search out surface water, consuming water as needed and remaining in the area until the weather changes (Fox et al. 2000; Byers 2003b). During these periods the spatial distribution of herds begins to match the distribution of water sources (Deblinger and Alldredge 1991).

The Plains environment not only gave the pronghorn plenty of running room and an unobstructed view, it also provided the proper dietary requirements, which allowed them to flourish. Unlike the bison, which is a grass and roughage eater, the pronghorn's diet is that of a selective feeder, choosing broad-leafed plants, which generally grow best where herds of bison have grazed off the grasses (Byers 1997; Heinrich 2001). The bison diet consists primarily of plants with digestible cell walls, whereas the pronghorn's diet places more "emphasis on the quickly digestible, protein-rich plant cell content" (Byers 1997:28). Being an opportunistic browser creates a certain degree of overlap with other

foragers. However, the pronghorn is a selective opportunistic forager feeding on forbs, shrubs, and grasses

The northern pronghorn focuses most of its food procurement energy on succulent new leaves, fruits, flowers and shoots in the spring. Forbs such as pasture sagewort (*Artemisia frigida*), moss phlox (*Phlox hoodii*), rose (*Rosa* sp.), prickly pear (*Opuntia polyacantha*) and shrubby cirquefoil (*Potentilla fruticosa*) are eaten during spring and summer. Shrubs or browse, such as silver sagebrush (*Artemisia cana*), creeping juniper (*Juniperus horizontalis*), western snowberry (*Symphoricarpos occidentalis*), and willows (*Salix* sp.), are eaten throughout the rest of the year (Barrett 1980; Glasgow 1990; Mitchell and Smoliak 1971; Stephenson et al. 1985). Silver sagebrush and pasture sagewort are the key foods of pronghorn in Alberta (Mitchell and Smoliak 1971; Wiltse 1978). In contrast, "sagebrush and creeping juniper were recognized as the essential or key foods of pronghorns in Saskatchewan" (Dirschl 1963:92). In addition, grasses and sedges were important items in the fall and early winter diet of pronghorn in the southern Alberta area (Mitchell and Smoliak 1971:243-244).

The main reason for the pronghorn's reliance on sagebrush during the winter is its high nutrient value in comparison to other winter forage species (Sundstrom et al. 1973). Sagebrush contains 81 % digestible nutrients, 8 % digestible protein, 12 % crude protein, 13.2 % crude fat, 18 % crude fiber, 52 % nitrogen free extract and 4.2 % mineral content (Sundstrom et al. 1973:29). These percentages are indicative of a plant with very high accessible nutrient content; in fact, the sagebrush has the highest concentration of winter nutrients of any western rangeland forage species

Although grasses and sedges have high summer importance for pronghorn, the areas within the pronghorn's summer range that have the greatest density of forbs constitute the preferred habitat. Dirschl (1963), Mitchell and Smoliak (1971), and Wiltse (1978) indicate that forbs comprised the most important part of the pronghorn's summer diet. In fact, although browse (predominately sagebrush and willows) frequently forms more than 75 % of the winter diet of pronghorns in northern ranges (Barrett 1980:192). However, forbs are the preferred food in all seasons and make up the largest part of the pronghorn diet (Yoakum 1990). As they become seasonally available, forbs can constitute anywhere from less than 20 to 99 % of the pronghorn's diet depending on rainfall or other factors that influence annual vegetation growth (Stephenson et al. 1985; Fox et al. 2000). Northern pronghorn populations make heavy use of forbs, especially from spring to late fall, and they are critical to high fawn survival rates (Yoakum 1990).

The differing diet of bison and pronghorn enabled both to coexist on the plains in a symbiotic way (Krueger 1986). When the bison moved through an area cropping the taller grasses, a herd of pronghorn would often follow not far behind grazing on the freshly exposed shoots and shrubs (Geist 1988). "Pronghorns also feed preferentially on recently burned prairie, where new green plants were available" (Byers 1997:29). If in fact the aboriginal populations did use selective burning as a way of controlling the movements of the bison herds they were also, either consciously or unconsciously, influencing the pronghorn's grazing activities.

2.6.3 Home Range and Territory

Home ranges extend from 440 to over 1200 ha for nursery and bachelor herds in Palouse Prairie habitat (Kitchen 1974; Byers 2003b). These figures are consistent with

pronghorn home range sizes in many grassland and grass-shrubland habitats. The variability of home range size depends on the habitat quality, intensity of grazing by other animals, overall population size, herd size, and season of the year. Therefore, no single home range size is typical for all pronghorn herds. Individual home ranges may be the same as or smaller than, but rarely larger than, the herd's home range. In general, winter home ranges for individuals are smaller than summer ranges because of restrictions on movement caused by snow. Individual winter home ranges in central Montana varied from 165 to 2300 ha (Bayless 1969). This data appears to be typical for individual pronghorns from other regions as well.

Today, pronghorn persist on small pockets of their former range, but seem remarkably efficient at exploiting drier, less diverse habitats (Byers 2003b).

2.6.4 Movements and Migration Routes

The pronghorn is considered to be migratory with seasonal movements often occurring over large areas. Movements are often dependent upon the quality and quantity of habitat. They tend to winter in large herds, with animals of both sexes feeding and bedding close together. During the spring pregnant does isolate themselves to give birth, and by late spring, doe-fawn groups have formed. Bachelor herds of young, non-territorial bucks are also common. Mature bucks are solitary at this time of year, often defending a territory or harem of does (Byers 2003a).

The pronghorn's nomadic behaviour ensures that they find diminishing water sources, locate areas previously burned by prairie fires to obtain the most nutritious forage, or move rapidly away from severe winter storms; unobstructed movement is vital to their survival (Byers 2003b).

Pronghorn migration is complex and poorly understood on a macro-level (Wiltse 1978); however, biologists agree that the animals follow traditional migration routes along the major drainage systems. Movement to wintering areas seems related to the amount of snow and cold weather a region is experiencing. The heavier the snowfall, the more intense the movements, with herds often drifting into valleys for shelter. The drainage systems of the Milk River offer this type of protection from the elements, a reasonable supply of sagebrush food, and a migration route into Montana (Barrett 1982; Mitchell 1980) (Figure 2.7).

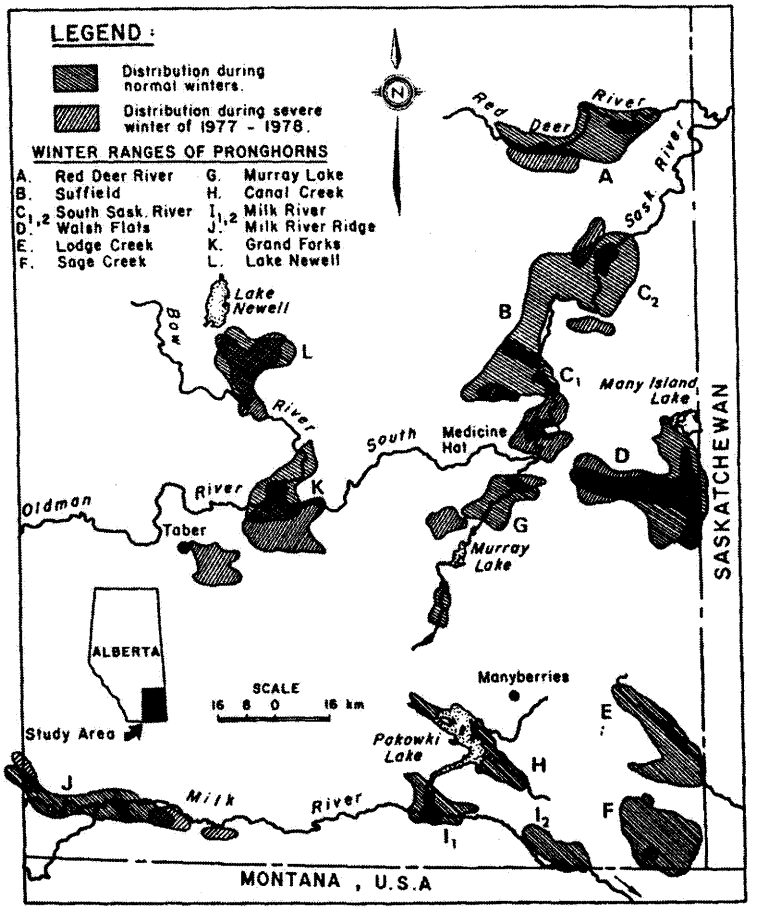


Figure 2.7 Distribution of modern Alberta pronghorn during normal and severe winters (Barrett 1982:993)

Several large herds of northern pronghorn are particularly interesting due to the fact that they spend their summers in Saskatchewan and their winters in Montana (Wiltse 1978) (Figure 2.8). This regular migration has given rise to what biologists from both countries call the "International Antelope Herd". These animals have displayed some

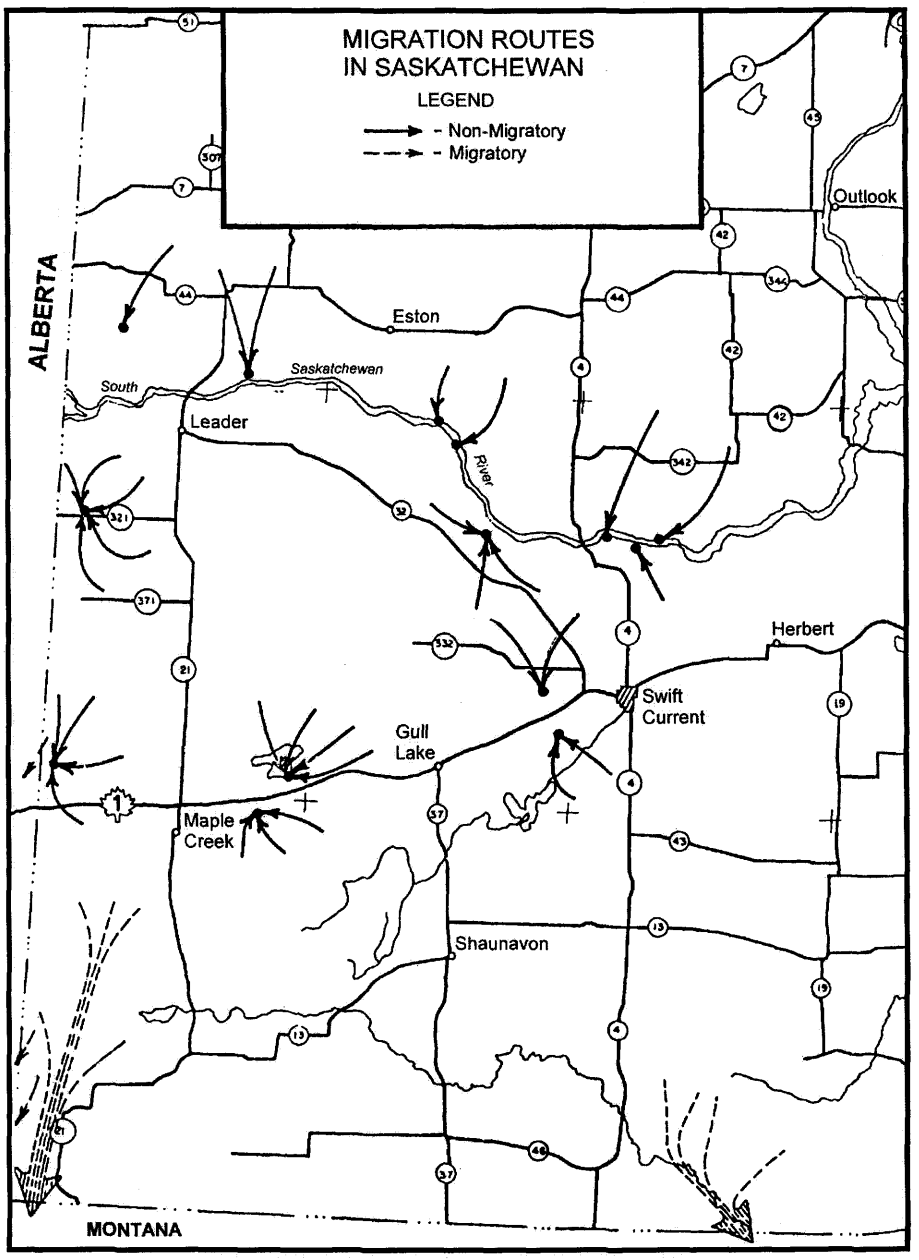


Figure 2.8 Saskatchewan pronghorn migration routes (Wiltse 1978:177)

tremendous movements, covering between 130 and 225 km from winter range to summer range (Mitchell 1980; Popowski and Pyle 1982).

Aside from avoiding the cold temperatures and deep snow, the quality of food must be attracting the pronghorn south into Montana. As snow piles up in the drainage systems north of the border and sagebrush becomes unavailable, the pronghorn are forced to move in search of food. For the "International Antelope Herd" the quality and quantity of sagebrush is a stimuli for migration (Popowski and Pyle 1982:56).

2.6.5 Wintering

Pronghorn have a high percentage of metabolically active muscles but little mass of metabolically inert fat. This ratio makes them very vulnerable to food shortages (Heinrich 2001). They need to be lean, and this leanness or lack of energy reserves can sometimes have a high price. It makes them vulnerable to periods of extended cold temperatures and deep snow, when energy expenditure must rise for heat production but food may be scarce.

One symptom of winter-induced malnutrition is the reduction of fat levels in pronghorn. "Low kidney fat indices and femoral fat of dead pronghorns indicates that malnutrition was the underlying cause of death" (Barrett 1982:999). The gelatinizing of femoral marrow, as well as low kidney fat levels is a reliable indicator of animals in poor condition brought on by nutritional stress.

Weather has often played a large role in the survival of Canada's pronghorn. This northern tension zone for pronghorn is noted for its extreme weather variations. Severe droughts as well as severe winters have an effect on both distribution and population numbers. Severe winters every 15 to 20 years have, at times, reduced the total

population by as much as 60 % (Barrett 1982). Fortunately, most of the winters in southern Alberta are characterized by warm westerly "chinook" winds that periodically reduce or remove the snow from large tracts of pronghorn range, exposing sagebrush and forbs for the hard-pressed pronghorns. In fact, the frequency of "chinooks" in the south may well be why we have so long enjoyed the presence of pronghorn in Alberta.

Canadian prairie winters are legendary for their ferocity. It is little wonder then that throughout the history of the pronghorn in Canada, there have been numerous large winter die-offs. Sagebrush has long been the vital shrub necessary for winter survival of pronghorns across the entire range. However, the large sagebrush, important in the diets of more southern pronghorns, does not grow at this northern latitude. Other species of plants, in this case another sagebrush, are substituted. The extent and quality of sagebrush available on wintering areas and the nature of the winter being experienced are major limiting factors governing the size of the population in Saskatchewan (Popowski and Pyle 1982:110). "Severe winters are [also] a problem for Montana's resident pronghorn" (Popowski and Pyle 1982:52).

Key wintering areas appear critical to the survival of pronghorns in northern latitudes (Bruns 1977). The relationship between the winter distribution of pronghorns and available habitat types reveals the importance of sagebrush and creeping juniper communities in Alberta and Saskatchewan (Dirschl 1963; Mitchell and Smoliak 1971; Wiltse 1978). In an exceptionally mild winter with little snowfall, pronghorns tend to be more widely scattered and show less dependence on defined winter ranges than in winters with moderate to heavy snowfalls.

During moderate winters pronghorn herds tend to seek shelter in valleys, returning to wind-blown hillsides where they paw through the snow to feed. In severe winters, many pronghorns leave their normal winter ranges, seemingly in response to a heavy accumulation of snow; overwinter mortality can be high, but animals which retain access to sagebrush areas fare the best (Barrett 1980; Bruns 1977).

The distribution patterns of sagebrush and creeping juniper indicates that suitable pronghorn range in southwest Saskatchewan is much less in winter than in summer (Wiltse 1978:173). The extent and quality of the winter range within each area of pronghorn occurrence are the limiting factors governing the size of the pronghorn population in Saskatchewan (Dirschl 1963).

The only regular winter areas, which are utilized annually by large pronghorn concentrations, occur within an area encompassing the Saskatchewan River grasslands east of the town of Leader. In addition, there are sporadic pockets of winter habitat north, west and south of Maple Creek, as well as some short term winter habitat north, west and east of Gull Lake (Wiltse 1978).

Due to the lack of suitable winter habitat large numbers of Saskatchewan pronghorns are involved in extremely complex migrations. While some non-migratory animals only move distances of 24 km to wintering areas, other migratory pronghorns move into southeastern Alberta. Still other herds of pronghorns utilize migration corridors that extend into Montana. These animals follow routes from Maple Creek through the Govenlock area or along the Frenchman River valley in order to get to their wintering grounds in Montana (Wiltse 1978).

The Cypress Hills pronghorn herd is another example of this winter survival strategy. Although part of the herd winters in sandy terrain north of the Cypress Hills range, other pronghorn remain on the eroded slopes and alluvial flats of the streams flowing south into the Milk River. The majority, however, are thought to winter along the Milk River drainage system in northern Montana (Dirschl 1963:86). The need of Saskatchewan's pronghorn population to travel more because of the lack of suitable habitat and food at specific times of the year is probably the reason for larger home ranges (Wiltse 1978:176).

2.7 Reproduction

2.7.1 Breeding Biology and Behaviour

Pronghorns are polygamous, gathering harems of does which range in size from two to 15 animals (Banfield 1974). The rut lasts from mid-September to early October in its northern range (Byers 2003b:1001), and from late July to early October in the south (Kitchen and O'Gara 1982:963). Although pronghorn on southern rangelands have breeding seasons as long as three months, those in most of the species' range have a comparatively short (about three weeks) and intense rut (Yoakum and O'Gara 2000:562). In Alberta, Saskatchewan, and Montana the bucks are strongly territorial during the rut; this is in contrast to animals on more southern ranges (Kitchen and O'Gara 1982; Popowski and Pyle 1982). Males fight for access to a female in estrus and to defend their territory, however, it is the female that ultimately controls mating. Territorial defense begins in late March or early April and lasts until the end of the rut (Bromley 1977; Kitchen and O'Gara 1982). "Fights are dangerous; 12% of fights end in the death of one male" (Byers 1997:204).

Females usually become sexually mature at 16 months of age but occasionally conceive at five months (Byers 2003b; O'Gara 1968). Does normally breed as yearlings for the first time and usually have one fawn, whereas twins and sometimes triplets are common in mature does (Figure 2.9). Does have four mammae, which allows for more than one fawn. Gestation is among the longest for big game species, lasting approximately eight months (230-250 days). Hepworth and Blunt (1966) and Yoakum and O'Gara (2000) all indicate that the gestation period for modern captive pronghorn averages 251 days. This difference is most likely caused be the closer observation available to researchers utilizing captive animals.

"[P]ronghorn females have the highest level of maternal investment in their offspring of any North American ruminant" (Yoakum and O'Gara 2000:562). For this reason, female pronghorn are especially sensitive to nutritional stress during the spring.

Birth occurs from late March to early June with the first week of June being the period during which most northern pronghorn fawns are born (Fairbanks 1993). At birth, northern fawns weigh between 2.3 and 3.2 kg (5 and 7 lbs), with the heavier individuals having a greater chance of survival (Yoakum 1978; Fairbanks 1993). Within four days of birth, a fawn can outrun a human and within a few weeks can run with the herd. They reach adult size at around six months of age.

Due to the predictable reproductive cycle of pronghorns a relationship exists between fetus bone size and a calendar date. This being the case, pronghorn fetus skeletal remains recovered from archaeological contexts may be used to estimate the mortality date of the remains and therefore the occupation season of the archaeological site (Fenner 2004).

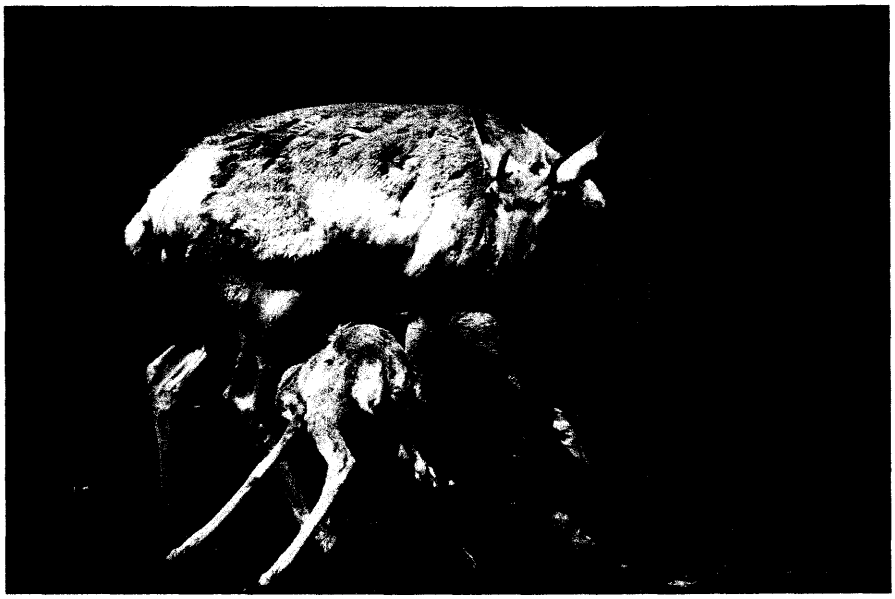


Figure 2.9 Pronghorn nursing twins

2.8 Mortality Factors

2.8.1 Pronghorn Survivorship

The average life span of the modern pronghorn is approximately 7 or 8 years, however, it is uncommon for a pronghorn to live beyond 10 years of age (Hepworth 1965; Kitchen and O'Gara 1982). "Male survivorship is lower than that of females due to risks of injury in rut, energy expenditure in rut and the consequent lower fat reserves at the start of winter, higher parasite loads in males than in females, and the fact that males senesce faster than females" (Byers 2003b:1004). However, given favorable environmental conditions, pronghorn have lived to 15 years of age or more (Yoakum and O'Gara 2000). Hepworth and Blunt (1966) stated that the oldest jaw in the Wyoming Fish and Game Department collection was from a 10.5 year-old doe, whereas O'Gara (1968), collected a doe in Montana that had been tagged as an adult and was thought to be over 10 years old. Kerwin and Mitchell (1971) found, via the cementum annuli testing method that Alberta pronghorn ranged in ages up to 15.5 years.

Mortality is usually highest within the first month of a pronghorn's life (Kitchen and O'Gara 1982:967). Failing teeth coupled with the stress of winter or droughts often weaken the older adult animals. Then they may die of pneumonia, predation, or any number of other causes. In addition, complications at parturition, prenatal abnormalities, congenital deformities, lightning strikes, hailstorms, miring in mud, drowning, locking horns, and injuries obtained while fighting all result in pronghorn deaths. In November 1991, a unique event involving dense fog resulted in 150 Wyoming pronghorn falling over a precipice to their death (Lubinski and O'Brien 2001; Ottman 1992). Although these causes of mortality may effect an individual animal or isolated herds, none are considered to be catastrophic to the population as a whole.

The most important mortality factor is winter severity, at least in the northern Great Plains region, which leads to accidental death, starvation, malnutrition, exposure, and predation by coyotes and dogs (Barrett 1982; Bruns 1977; Kitchen and O'Gara 1982). Although some animals succumb each winter, a particularly severe winter may indiscriminately kill pronghorns of all age, resulting in the death of hundreds of individuals (Barrett 1978).

2.8.2 Predation

In addition to humans, present day pronghorn predators include coyotes (*Canis latrans*), bobcats (*Lynx rufus*), mountain lions (*Felis concolor*), golden eagles (*Aquila chrysaetos*) and feral/domestic dogs (*Canis familiaris*).

> [The pronghorn possesses] remarkable courage, and under ordinary circumstances, do not trouble themselves to get out of the way even of the large buffalo wolves. A single antelope will bravely face a single wolf, and successfully beat off his attack, and a herd does not fear the attack of any number of wolves. Wherever the antelope are numerous there will generally be found plenty of wolves, who lie around the herd

> at a little distance, watchful and ready to take advantage of any accident in their favor; now pouncing upon one which has strayed from the protection of the herd, making a prompt meal of any one which should happen to be sick, or get injured in any way (Dodge 1959:201).

The primary Holocene predator of the pronghorn is the coyote, especially when the snow is deep (Bruns 1977). In summer the coyotes concentrate on the young fawns, but does will drive off a marauding coyote by trying to spear it with their sharp hooves, sometimes even killing it in this way (Banfield 1974:403). In Alberta, nearly 68 % of the fawn mortality in one study was attributed to coyotes and bobcats (Mitchell 1980; Popowski and Pyle 1982:243).

Eagles also occasionally prey on fawns, and each year fawns are killed by exposure, abandonment, or disease. The effects of predators on adult mortality seems slight (Byers 2003b:1004). Mountain lions (*Felis concolor*) occasionally kill pronghorns when terrain or cover permits a close stalk. Wolves rarely pursue pronghorn when slower prey is available. Large coyotes can kill pronghorn adults, but such events are rare. Losses of pronghorn due to predation vary with pronghorn and predator numbers, habitat type, and availability of alternative food sources for predators. Healthy pronghorn in preferred habitat experience very little risk from any modern predators (Byers 2003b).

2.8.3 Anti-Predator Behaviour

Pronghorn are unquestionably the fastest mammal in North America (Byers 2003a:4) having the evolutionary adaptations necessary for both speed and endurance. They accelerate explosively from a standing start to quickly reach a top speed of close to 100 km/h (60 mi/h) (Kitchen and O'Gara 1982; McCabe et al. 2004; Popowski and Pyle 1982;Yoakum 1978). Even though exhaustion occurs rapidly during these short (3-4

minute) sprints, pronghorn can easily cruise at 48-70 km/h (28-45 mi/h) for up to 6.5 km (4 mi) (Banfield 1974; Lindstedt et al. 1991; Yoakum 1978). "Pronghorns are also capable of bounding 3.5-6.0 m (12-20 ft) or more" (Yoakum 1978:108).

The pronghorn deals with predators by putting distance between itself and the perceived threat. "The pronghorn does not hide but uses distance for safety" (Popowski and Pyle 1982:261). Essentially a pronghorn does not care if it is spotted by a hunter as long as there is a vast expanse of land that can be put between the hunter and pronghorn. "When caught in the common ground, each instinctively made for what to him was the safest place. The black-tail [deer] relies on concealing himself from the sight of his enemy; the antelope on keeping the hunter in view and himself beyond range of possible danger" (Dodge 1959:106). This is accomplished by the fabulous speed of the pronghorn (Popowski and Pyle 1982:261-262).

Pronghorn herds are thought to function as escape cover for individuals (Kitchen 1974), and frightened individuals seek a herd when escaping from predators. Thus utilizing the "safety in numbers" defensive strategy. Pronghorn herds flee in an elliptically-shaped formation and may run at speeds of 64-71 km/h (Kitchen 1974). Individuals, however, run faster than a herd and as noted above, can reach speeds approaching 100 km/h (Kitchen and O'Gara 1982:967) (Figure 2.10). Pronghorns, therefore, use a strategy of speed and the cover of the herd to escape from predators. The pronghorn's body markings may also act as a visual distraction to predators and keep the predators from singling out an individual to pursue (Kitchen 1974).

Figure 2.10 Running southeastern Alberta pronghorn

In addition to speed, exceptional eyesight is the main defense of pronghorns since they can detect movement up to 6.5 km away (Popowski and Pyle 1982; Glasgow 1990). However, a fawn's best defense from predators is to choose a good bed site cover and lie motionless (Byers 1997, 2003a).

Pronghorn have a habit of running at top speed until they are out of sight of whatever scared them, but then seem to quickly forget about what they were fleeing from and rapidly settling down to graze (Arkush 1986; Byers 2003a). Prehistoric hunters as a means to stay in contact with and eventually wear down a selected animal could have utilized this behavioural characteristic. Also, if during stalking a hunter was spotted and the animal fled, the hunter at least knew that if he continued in the direction that the pronghorn ran, he might eventually spot it again (Frison 1991a:240). "Consequently, a single hunter could successfully stalk them" (Frison 1978:252).

While pronghorn were a readily available food source throughout much of the northern Plains in precontact times, "their quickness and keen eyesight probably aided

them in maintaining a relatively stable population in the face of human predation" (Arkush 1986:252).

2.9 Ethology

2.9.1 Introduction to Pronghorn Ethology

Ethology is the attempt to understand the behaviour of animals in their natural environment or the study of the biology of animal behaviour. Central to the ethologist's approach is the principle that animal behaviour is subject to evolution through natural selection. Ethologists therefore seek to explain how the behaviour of an animal in its natural environment may contribute to the survival of the maximum number of its relatives and offspring. "In animals, structure, behavior and mode of life form an integrated adaptive unity, a biological trinity, of which no one component is comprehensible except in relation to the other two" (Ewer 1968). The term ethology is used here to describe the study of the way in which these three are inter-related. Modern ethology concentrates on behaviour rather than structure, but the inter-relations with the other two members of the trinity remain essential.

Ethology is relevant to this research based on the fact that prehistoric Plains people would have utilized the behavioural characteristics of the pronghorn in order to bring about its successful procurement. In contrast, the pronghorn's behaviour would have been its primary defensive system to be used in the avoidance of procurement. "Animal behavior was a major determinant of hunting strategies and ultimately ones knowledge of the intended prey species behaviour determined ones chances of a successful kill" (Frison 2004:228). Almost certainly, pronghorn have remained essentially unchanged as far as behavioural characteristics are concerned (Byers 1997).

Therefore, modern populations can be used to make analogues regarding Holocene pronghorn populations and their behaviours.

2.9.2 Jumping Ability

One area of modern behaviour that has direct implications to Holocene pronghorn hunting is how pronghorns have (or have not) learned to deal with livestock fences. Pronghorn are not able to cope with livestock fences very well. Unlike animals such as deer, they are more likely to crawl under a fence 1.2 m (4 ft) high, if possible, than to jump over it. Frison (1991a:240) comments how "more than once [he has] seen a single strand of barbed wire stretched across sagebrush at about a meter off the ground contain a sizeable herd of antelope because the animals refused either to jump over it or crawl under it." In fact, when cornered, pronghorn will double back and run within a few metres of their pursuer rather than go over or under the barbed wire.

Pronghorn have been known to get entangled or injured while going under, or attempting to jump a fence, often resulting in death (Frison 2004:124). Indeed, hundreds of pronghorn have died when heedless ranchers built fences with no bottom clearance across fall migration routes (Byers 2003a:6).

Pronghorn even hesitate to jump across gullies or streams, although, occasionally some individuals do jump across small streams or other low obstacles (Byers 2003b:1003) and they may leap over fences in high-stress situations (Popowski and Pyle 1982:37). Having said this, the pronghorn has had over 100 years to become familiar with wire fences, but the animal is still not comfortable with these barriers. If they do jump, they usually land on the hind feet first, a most unusual looking maneuver.

"Pronghorn probably avoid jumping to avoid the risk of snapping the lower limb bones when all of the body's weight comes down on them" (Byers 2003a:6).

Another theory is that although the pronghorn has powerful jumping capabilities, they have simply not evolved the behaviour of making vertical jumps, like forest-dwelling deer. Although the task would seem to be trivial for its body, its mind does not reach that high. A pronghorn simply cannot conceive of jumping over a fence (Heinrich 2001:126).

2.9.3 Activity Patterns

The daily and seasonal movements of pronghorns are somewhat predictable (Lubinski and Herren 2000). Pronghorns are chiefly diurnal, being most active during the morning and evening, however, they may be seen moving at any time. These peaks are most evident during the hottest days of the year (Kitchen 1974). Pronghorns follow a cycle of feeding, bedding, ruminating, and in the driest areas, often moving to and from free water. Actual schedules of these activities vary from day to day and show regional and seasonal variations as well (Kitchen and O'Gara 1982:965). Nocturnal bouts of feeding are shorter than diurnal bouts and bedding periods are longer at night. Knowing the pronghorn's daily behavioural routine would certainly be advantageous for the prehistoric hunter, especially if the individual wanted to ambush his prey.

2.9.4 Migratory Behaviour

Migratory behaviour a key characteristic to understanding prehistoric pronghorn procurement as these predictable reactions were effectively utilized by aboriginal hunters in the acquisition strategies that were applied to this animal. In general, pronghorn do not follow any set pattern of migration, as do other animals such as the

caribou (*Rangifer tarandus*). Einarsen (1948:11-12) stated that "...[pronghorn] may change feeding grounds several times within the year, but their drift from one range to another is not usually a long trek, lacks rhythm, and will [as] often be northward as southward in winter". This means that they could not be hunted by planning where they would be at any point in time, but instead could be successfully hunted by opportunistic groups, especially during the fall and winter, when they come together in large herds (Arkush 1986:241).

Most northern pronghorn populations will undertake unpatterned regionally specific seasonal movements between summer and winter ranges (Bruns 1977; Byers 2003a). In general, these seasonal habitat shifts move animals, during winter, to areas where the climate is milder and snow depth less, and in summer to moister area where forb diversity and abundance is greater. The pronghorns of Canada and Montana have been known to move considerable distances, especially during winter storms. "During the harshest months of winter the herds moved extensively in a generally southward direction" (Bruns 1977). In Idaho, pronghorns move to and from winter ranges in response to forage succulence and not weather conditions such as snow depth and cold wind.

During the period of time when pronghorn are on their summer ranges, individuals tend to be site faithful (Byers 1997). In spring, pronghorn moved to their summer ranges as forage became more succulent; and in winter, they followed a reverse gradient of forage succulence back to their winter range (Hoskinson and Tester 1980). As mentioned above, pronghorn populations may make seasonal habit shifts between summer and winter ranges. Such movements often involve distances of 18 to over 160

km (Kitchen and O'Gara 1982), and in one case a Wyoming herd makes an annual 548 km round trip (Berger 2004:331). In contrast, these shifts can also be less than 3-4 km in distance (Kitchen 1974; Hoskinson and Tester 1980).

Seasonal habitat shifts can also be associated with changes in herd size, sex composition, and individual activity budgets (Byers 1997). In summer, group sizes are smallest. Males greater than three years of age tend to be solitary or with a group of females and young. Males that are 1-3 years old tend to be in herds (often referred to as bachelor herds). Much larger, mixed-sex pronghorn herds form in fall and winter. Activity budgets of males and females vary with the season. In winter, when individual energy budgets tend to be negative approximately 80% of a pronghorn's day is spent either feeding or reclining (Bear 1971). The other 20% of the time consists of movements in search of food or sheltered locations in which to bed down (Byers 2003b).

This means that pronghorn could not be hunted by planning where they would be at a specific point in time, but instead could be profitably hunted as opportunistic groups, usually during fall and winter, when they come together to form larger herds (Arkush 1986:241). Although this may be the case, evidence from the Trappers Point Site (48SU1006) would seem to indicate that at least some regional herds did have established migration patterns and these routes were utilized by prehistoric populations (Sanders and Wedel 1999; Miller and Sanders 2000; Sanders and Miller 2004).

2.9.5 Group Behaviour

Knowledge of seasonal herd size and behaviour is another skill that would benefit the prehistoric hunter. Pronghorns are social animals and form herds (Figure 2.11). The reproductive state of an individual, its sex, and the season of the year all influence herd

size. Winter herds contain all sex and age classes and range in size from two to thousands of animals (Kitchen and O'Gara 1982:964-965). As winter abates, these large herds break up into smaller herds according to sex and age. Young males (one to four years old) form bachelor herds of 2-40 animals; females form herds of 5-20 animals and may associate with older males (more than five years old). As does approach parturition, they leave the herd and scatter over large areas to give birth (Bromley 1977; Kitchen 1974). When fawns are three to six weeks old and capable of sustained, rapid flight, does form nursery herds of 2-20 individuals accompanied by their fawns and yearling does. Older males are solitary during summer, but associate with nearby nursery herds (Kitchen 1974). As rut begins, bachelor herds break up and young males wander alone or in small groups that move from area to area harassing large males with does (Kitchen and O'Gara 1982:965). During rut, females are aggregated or alone and frequently move from one large male to another (Kitchen 1974). Large males are usually with female groups during the rut, but may be solitary if no females are foraging on their territories.

"The mean herd size of pronghorns was markedly lower in the seven month period from April to October and higher during the winter months. Pronghorns are more widely distributed and occurred in smaller herds during the month of May than at any other time of the year; that time period coincides with the parturition period for pronghorns in Alberta" (Barrett 1980:177-179).

Figure 2.11 Montana pronghorn herd in the late fall

2.9.6 Curiosity

The final behavioural trait of the pronghorn is the general inquisitive nature of the species. Curiosity is another characteristic of pronghorns likely to have been exploited by hunters in the past (Frison 1987, 1991a). Pronghorn will often come to investigate anything unusual or unfamiliar in their territory that does not cause alarm by scent or sudden movement (Nowak and Paradiso 1983). Although they can see great distances, they apparently lack visual acuity, and a motionless person only 10-15 m away may be ignored (Kitchen 1974). Its "curiosity" is a adaptive attempt to identify strange sights so as to minimize unnecessary, and costly, running (Geist 1988:206).

Any object that cannot instantly be identified by a pronghorn, will cause the animal to approach closer and closer often bringing them within the range of a waiting hunter. "A sure method to obtain a pronghorn is to camp out in antelope country and put up a small tipi or tent or lay a blanket on top of a sagebrush where it can be seen for long distances. Provided of course that there are animals in the area, the next morning a number of them are likely to be moving in to see what the object is and will usually approach to within easy shooting distance if the hunter has the patience to remain quiet"

(Frison 1991a:240). This hunting strategy is mentioned in a number of ethnographic accounts (see Chapter 4) and very likely played a prominent role in the prehistoric small-scale procurement of pronghorn on the northern Plains.

2.10 Conclusion

Effective methods for hunting any game species are determined in large part by the habits of the prey (Frison 2004). Pronghorn have a number of characteristics that can, and were, exploited by the hunter. This chapter has focused on the unique nature of the pronghorn in order to provide background information that will aid in the formulation of a valid northern Plains pronghorn procurement strategy. In order to understand the behavioural patterns of the northern Plains hunter, the behavioural patterns of the intended prey must first be understood and this chapter attempts to provide that background information.

Prehistoric northern Plains hunters were accomplished predators. "They were totally familiar with, and able at a moment's notice to draw upon, a comprehensive body of knowledge concerning the habits of the numerous species and their responses to different internal and external conditions" (Frison 1987:218-219). Typical prehistoric hunters had to be intimately aware of their environment in order to survive. When they combined this knowledge base with the understanding of the behavioural patterns of the animal or animals they intended to hunt on that day, they could depart camp confident that the probabilities of procuring sustenance were strongly in their favor. This would be true if the hunter were going out alone, with one or two other companions, or in the company of a group of hunters to engage in a communal effort.

CHAPTER THREE

Archaeological Sites Pertinent to Northern Plains Pronghorn Research

3.1 Background

3.1.1 Overview of Relevant Archaeological Sites

Species such as bison, pronghorn, or Rocky Mountain bighorn sheep display a distinct set of behavioural characteristics and prehistoric hunters had to know how to exploit specific behaviours for procurement events to be successful (Frison 1991b, 2004). Numerous archaeological sites on the Plains attest to the past successes of prehistoric populations with regards to their hunting endeavours. A review of the literature concerning archaeological sites on the northern Plains and neighboring areas indicates that aboriginal groups since their early occupation of western North America have exploited pronghorn. In fact, the practice of pronghorn procurement spans the Paleoindian period into historic times (Frison 1991a).

Regarding the archaeological evidence for pronghorn hunting on the Plains, the faunal assemblages coupled with the remains of hunting and habitation structures present the best evidence of this subsistence activity. In addition, the ethnographic and historic accounts assist in the substantiation of the archaeological site data.

Due to the extensive range of both the pronghorn and Plains culture, archaeologists have evidence from a variety of different locations. The pronghorn's prehistoric range extended from the Red River in Manitoba to the foothills of the Rocky Mountains and as

far south as northern Mexico (Cordell 1997). This area is vast and archaeologists have excavated only a fraction of the sites that exist. Luckily, several important sites have been located, and these have provided evidence that the pronghorn represented an important source of food and clothing for the Plains people.

The pronghorn has been an element of the human diet on the Plains for more than ten thousand years. "Pronghorn are found in Clovis sites but in relatively small numbers" (Frison 2004:61). Paleoindian sites which contain evidence of pronghorn procurement on the Plains include: the Sheaman and Agate Basin site dated at approximately 11,000 years ago (Frison 1982c; Frison and Stanford 1982), the Casper Local fauna, dated to 10,000 years ago (Frison 1974a) and the Sister's Hill site, also approximately 10,000 years old (Agogino and Galloway 1965) (Figure 3.1). In addition, pronghorn remains have been recorded from post-Hell Gap levels at the type Hell Gap site (Irwin-Williams et al. 1973), and from a 8,600 year old component in Schiffer Cave (Frison 1991a).

Pronghorn remains are surprisingly scarce in Middle Period sites, but they do exist at sites such as Sun River (Greiser et al. 1985), Gowen I (Walker 1992), Lightning Spring (Keyser and Wettstaed 1995), Trappers Point (Sanders and Miller 2004), Laidlaw Antelope Trap (Brumley 1983, 1984) and Cactus Flower (Brumley 1975).

Evidence of pronghorn procurement is much more common during the Late Prehistoric period. Evidence for this has been recovered from sites such as Pictograph Cave (Mulloy 1958), the Skull Point (McGuire 1977), Glenrock Buffalo Jump (Frison 1970), Lost Terrace (Davis and Fisher 1988), Saamis (Milne-Brumley 1978), Oyster Ridge (Zier 1982), Blakiston (Dau 1990) and Eden-Farson (Frison 1971b, 2000a,

2000b). This site list is by no means exhaustive. Brief descriptions of the above-mentioned sites, as well as a few additional sites, are documented below. For a condensed table of Canadian and United States of America archaeological sites that contain pronghorn remains refer to Appendix B.

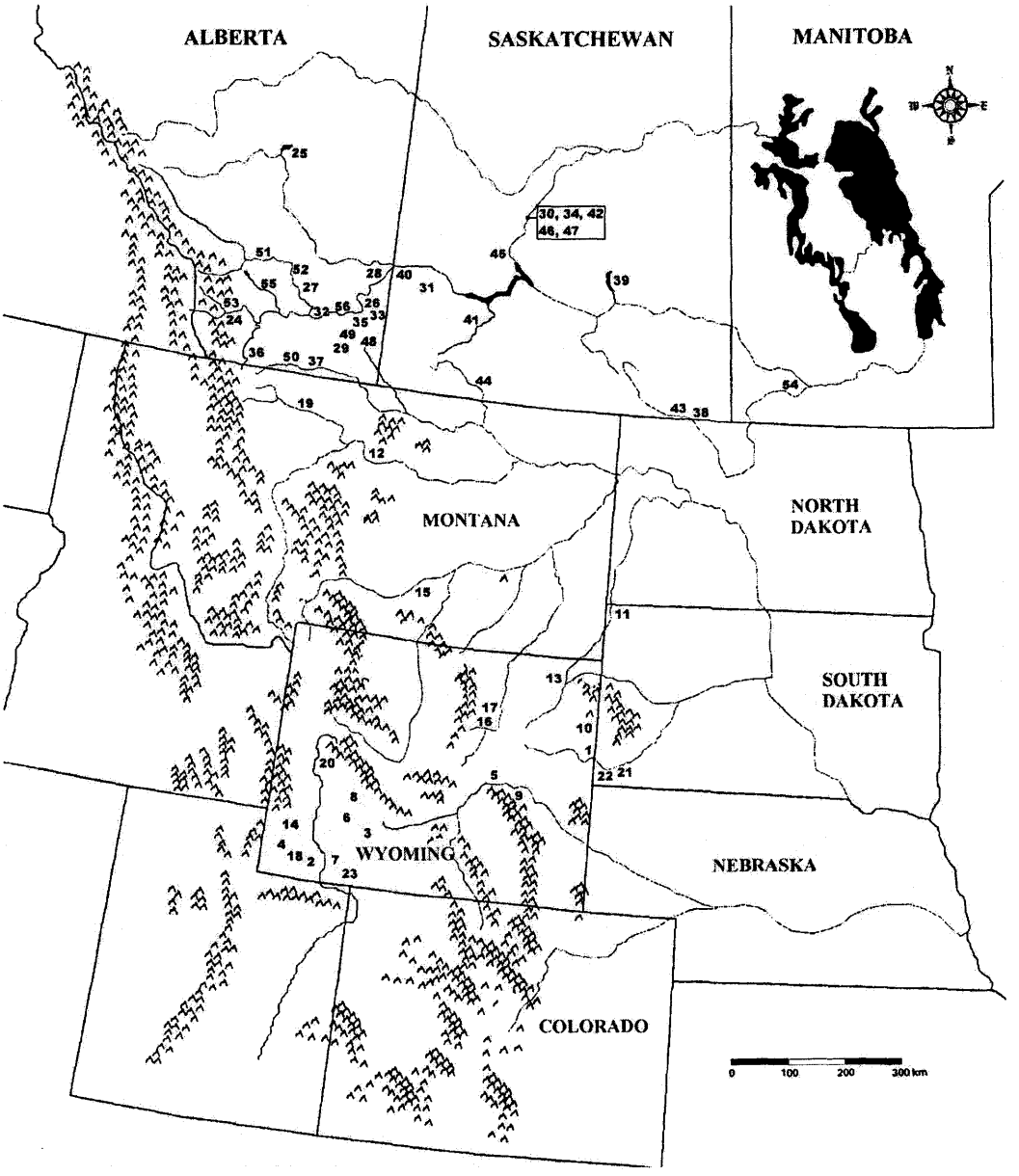


Figure 3.1 Archaeological sites containing pronghorn remains:
1. Agate Basin Sheaman Locality (48NA211) and Agate Basin site (48NO201), **2**. Austin Wash site (48UT390), **3**. Boar's Tusk site (48SW1373), **4**. Bridger Antelope Trap (48UT1), **5**. Casper site (48NA304), **6**. Eden-Farson site (48SW304), **7**. Firehole Basin #11(48SW1217), **8**. Gailiun site

(48SU1156), **9**. Glenrock Buffalo Jump (48CO304), **10**. Hawken site (48CK303), **11**. Lightning Spring site (39HN204), **12**. Lost Terrace site (24CH68), **13**. Little Missouri Antelope Trap (48CK49/69), **14**. Oyster Ridge site (48UT35), **15**. Pictograph Cave (24YL1), **16**. Schiffer Cave (48JO319), **17**. Sister's Hill site (48JO314), **18**. Skull Point site (48LN317), **19**. Sun River site (24CA74), **20**. Trappers Point site (48SU1006), **21**. 39FA23, **22**. 39FA83, **23**. 48SW270, **24**. Blakiston site (DjPm-115), **25**. Boss Hill site (FdPe-4), **26**. Cactus Flower site (EbOp-16), **27**. EdPc-10, **28**. Empress Tipi Ring site (EfOo-130), **29**. Forty Mile Coulee (DjOu-62), **30**. Gowen I site (FaNq-25), **31**. Heron Eden site (EeOi-11), **32**. Laidlaw Antelope Trap (DlOu-9), **33**. Larson site (DlOn-3), **34**. Newo Asiniak site (FbNp-16), **35**. Saamis site (EaOp-6), **36**. St. Mary Reservoir (DhPg-8), **37**. Writing-On-Stone Provincial Park, **38**. Sanderson (DhMs-12), **39**. Lake Midden (EfNg-1), **40**. Estuary site (EfOk-16), **41**. Gray site (EcNx-1a), **42**. Thundercloud site (FbNp-25), **43**. Oxbow Dam site (DhMn-1), **44**. Bracken Cairn (DhOb-3), **45**. Sjovold site (EiNs-4), **46**. Tipperary Creek (FbNp-1), **47**. Amisk (FbNp-17), **48**. Galt Island Bluff (EaOq-VP), **49**. DjOu-5, **50**. DgOv-93, **51**. Hartell Creek (EgPi-1), **52**. Cluny (EePf-1), **53**. Kenney site (DjPk-1), **54**. Stendall (DkMh-1), **55**. Little Bow Reservoir (EbPi-75), **56**. Bow Island site (DlOu-72)

3.2 Significant Sites (United States of America)

3.2.1 Montana

3.2.1.1 Lost Terrace Site (24CH68) (Communal Procurement)

One of the more impressive sites that provides evidence for pronghorn procurement is Lost Terrace (24CH68). This Late Prehistoric, Avonlea phase, single-component pronghorn-processing site is situated in north-central Montana on the bank of the upper Missouri River (Davis et al. 2000).

The features uncovered at this site included a lithic workshop, a hide working station and a pronghorn processing area, with an associated habitation site located upslope (Davis and Fisher 1990:243). The central component consists of a dense midden deposit exposed along the shoreline for a distance of 25 m and at a depth of 1.8 m below the terrace surface (Brumley 1983:38). The refuse midden at the site contained a large quantity of thermally-altered rock and charcoal, in addition to lithic, bone, and shell artifacts (Davis and Fisher 1988, 1990; Davis et al. 2000).

Recovered bone and charcoal samples were used to obtain numerous radiocarbon dates, including; 1045 ± 180 B.P. (I-9048), 925 ± 80 B.P. (I-9172) 1110 ± 100 B.P. (RL-818), and 1190 ± 60 B.P. (Beta-123151) (Davis and Fisher 1988:108). In addition to

utilized pronghorn bones, numerous Avonlea projectile points were also recovered from the midden (Greiser 1988). These lithics have been interpreted as evidence for the hunting of these animals with the bow and arrow, possibly in a single group kill event (Davis and Fisher 1990:245).

Archaeological bone constitutes the most numerous cultural material recovered at Lost Terrace. An minimum number of individuals (MNI) of 56 adults, subadults and fetal pronghorn, when compared to an MNI of 1 bison, indicates that this species was the primary prey at this kill episode (Davis and Fisher 1988:107). This is not surprising as "the Lost Terrace Site occurs in the zone of maximum pronghorn abundance in western North America" (Davis and Fisher 1988:103).

Analysis of stage of growth and development established the death of fetal pronghorns from mid-to late winter, approximately late January to early March (Davis and Fisher 1990:253). Winter mortality was also indicated by the stage of tooth eruption reached by juveniles (Davis and Fisher 1988). These data place the kill event during the season of maximum pronghorn herd size. The reason this event took place is interpreted as a response to an anomalous, life-threatening winter food-provisioning situation (Davis and Fisher 1988). Davis and Fisher (1988) noted that during the winter months, skilled, knowledgeable, resourceful and opportunistic prehistoric hunters would have had access to more aggregated pronghorn located in predictable places which would have made these animals vulnerable to a variety of hunting strategies. It is possible that the decision to procure pronghorn at Lost Terrace was stimulated by an unusual food shortage, perhaps caused by an extended period of severe weather (Davis and Fisher 1990:269).

In discussing the Lost Terrace site's relation to several essentially contemporaneous Avonlea occupations elsewhere in the northern Plains, Davis (1976:56) states: "Since bison were clearly the focal prey sought by Avonlea Phase hunters at all the sites [excavated to date], except Lost Terrace, and since the [other] manifestations are essentially contemporaneous, it seems clear that Avonlea Phase hunters had developed alternate subsistence orientations to the procurement of resident big game species". In addition, it is tempting to suggest that late in their history Avonlea hunters were influenced by populations for whom pronghorn hunting was commonplace. Cultures that perhaps were more closely adapted to the northern periphery of the Big Horn basin area would be likely candidates (Davis 1976:56). This statement appears to reflect the assumption that communal pronghorn procurement, as Lost Terrace presumably reflects, is not typical or common place to aboriginal groups on the northern Plains and reflects outside influences.

Available data support "the notion that pronghorns were a regularly selected secondary prey, sometimes taken individually or in small numbers, but very seldom selected as focal prey on a communal scale by Prehistoric bison hunters" (Davis and Fisher 1988:113). An interpretation of the site as a single component resource processing site formed by users of Avonlea projectile points who killed pronghorns to prevent starvation firmly establishes the pronghorn as a utilized secondary species of importance on the Plains.

3.2.1.2 Pictograph Cave (24YL1) (Small-Scale Procurement)

Pictograph Cave located near Billings, Montana reflects continual, long–term pronghorn procurement beginning with the middle Plains Archaic and on through the

Late Plains Archaic and Late Prehistoric periods but only in small numbers" (Frison 1991a:246). For addition information on this site refer to Mulloy (1958).

3.2.1.3 Sun River Site (24CA74) (Small-Scale Procurement)

The Sun River site is located near Great Falls, Montana and is situated on a level flood plain approximately 300 m north of the present channel of the Sun River, a tributary of the Missouri River (Greiser et al. 1985:849). This stratified, multicomponent campsite produced radiocarbon dates ranging from 5670 ± 190 B.P. (Beta-5527) to 3450 ± 350 B.P. (Beta-5536), placing the various components within the time-spread of the Oxbow complex (Greiser et al.1985:853).

The living floors at Levels IV and V both contained at least one hearth, heat-altered rocks, numerous Oxbow projectile points, flaked stone tools and tool fragments, as well as lithic debitage. The faunal remains, both burned and unburned, were heavily fragmented and included a wide variety of species. At Level IV, bison (MNI 3) was the predominant species with pronghorn (MNI 1) a distant second (Greiser et al.1985:858). For Level IV "[t]he limited pronghorn bones probably represent a single adult, and the remains of the other species are extremely limited" (Greiser et al.1985:858). The heavy fragmentation was "perhaps a result of cultural activities such as butchering, marrow removal, and bone-grease processing", with a "limited amount of meat and grease...having been derived from the pronghorn" (Greiser et al.1985:857-859). Based on juvenile bison dentition the season of occupation was calculated to be mid fall or early winter.

At Level V bison (MNI 6) again was the predominant species with pronghorn (MNI 1) second (Greiser et al.1985:862). The pronghorn bones represent a single individual:

"Only the left mandible and teeth are complete enough to yield any idea of age. Tooth eruption and wear patterns on the first molar are characteristic of a 2.3-year-old (Nimmo 1971), which would place time of death in mid- to late fall, thus complementing the bison seasonality" (Greiser et al. 1985:862). The pronghorn, assuming that a complete individual was exploited, would have provided an additional average of 20.5 kg (45 lbs) of meat and over 1 kg (2 lbs) of fat and grease (Frison 1971b). "From the notable degree of bone fragmentation, we infer times of exceptional need" (Greiser et al. 1985:863).

Again based on the presence of Oxbow projectile points, cultural Level VI was occupied by an Oxbow culture group, around 5200 years ago. The living floor/bone-processing activity area contained a hearth, heat-altered rock, lithic tools and debitage, along with numerous fragmented pieces of bone. "Collected from the [hearth] feature were a number of pronghorn bone fragments, primarily from long bones, and several rodent bones. [It is] inferred that this feature was the end product of marrow-processing activities" (Greiser et al. 1985:865).

Represented fauna included pronghorn, bird, deer, rodent, bison, jackrabbit, and wolf remains; the pronghorn faunal elements comprised 78.2% of the identifiable sample (Greiser et al. 1985:867-868). Extensive fragmentation is characteristic of the Level VI faunal assemblage. "The extremely fragmented nature of the pronghorn bones, even down to utilized mandibles and phalanges, fit well with other documented pronghorn-processing sites" (Greiser et al. 1985:869). "The most frequent elements, pronghorn maxillae and mandibles were fragmented during butchering, presumably to maximize marrow retrieval. In combination with three mandibles, the five maxillae were examined

to determine that a minimum of four pronghorn were killed and butchered in the fall or early winter" (Greiser et al. 1985:868).

The four pronghorn processed by occupants of Level VI would have yielded approximately 82 kg (180 lbs) of meat and more than 3.5 kg (8 lbs) of fat and marrow (Frison 1971b). "Using the estimate of 3.5-5 lbs of meat per person per day, the pronghorn meat would have provided 51.5 person days of meat, or 25 people meat for two days" (Greiser et al. 1985:869)

In Level IV, which, dates to approximately 3500 B.P. bison remains comprise 95% of the identified fauna while pronghorn is minimally represented in the level (3%). At 4500 B.P. (Level V), bison bone comprises 65% of the sample and 21% are identified as pronghorn. In sharp contrast, at 5200 B.P, (Level VI) bison comprise only 3% of the sample and pronghorn comprise 78% (Greiser et al. 1985:874). The earliest known occupants of the site emphasized pronghorn, perhaps a reflection of the pronghorn's adaptation to the drier portions of the shortgrass plains. Occupation of the site in the autumn is believed to reflect a subsistence pattern that responded to the congregation of large herbivores during the breeding season. Apparently, several families came together to exploit these resources (Greiser et al. 1985:874).

3.2.2 South Dakota

3.2.2.1 Lightning Springs (39HN204) (Communal Procurement)

Lightning Spring is a stratified, multi-component site discovered in the fall of 1979 during a survey of the North Cave Hills in South Dakota (Keyser and Davis 1984; Keyser and Wettstaed 1995). Initial excavations took place in 1980 (Keyser and Davis 1984) with further excavations in 1991 (Keyser and Wettstaed 1995). The later

excavations exposing the deeper stratum which included the Middle Archaic Period occupations.

The North Cave Hills are a large, flat-topped mesa formation rising 45 m from the surrounding rolling prairie. Situated just below the rimrock on the east flank of the mesa, Lightning Spring is centered in an ecosystem mosaic comprising five distinctive ecozones that occur within 2 km of the site (Keyser and Davis 1984:2). "The result of this mosaic is a catchment area characterized by an array of plant and animal resources that is remarkably diverse for this area of the Northwestern Plains" (Keyser and Wettstaed 1995:2). Game animals would have included bison, elk, deer, pronghorn, and mountain sheep. All except the elk have been recovered from the site deposits (Keyser and Davis 1984:2).

The site's cultural features include a prepared fire hearth basin and two smaller, very shallow, ovoid basin-shaped depressions, located adjacent to the hearth (Keyser and Wettstaed 1995:7). Associated with these are lithic tools, ground stone and antler tools, lithic debitage and faunal and floral remains (Keyser and Davis 1984; Keyser and Wettstaed 1995).

Diagnostic artifacts include 14 Duncan type projectile points which, when combined with radiocarbon dates of 4040 ± 90 B.P. (Beta-58279) and 4200 ± 170 B.P. (Beta-58280), place the lower levels (Stratum 11-14) into the McKean Phase (Keyser and Davis 1984:45; Keyser and Wettstaed 1995:7-10).

It is these lower strata that the majority of the pronghorn remains are associated with (Keyser and Davis 1984:36)."Bone preservation was generally good, with bones being wet and friable when first excavated, but becoming hard once exposed to air" (Keyser

and Wettstaed 1995:18). However, most of the faunal remains were not identifiable to element or species due to the fragmented nature of the assemblage. "It is likely...that most of the small crushed bone fragments are the result of grease extraction" (Keyser and Wettstaed 1995:19).

Of the 62 identifiable elements six taxa are represented: bison, pronghorn, deer, Rocky Mountain bighorn sheep, cottontail rabbit and jackrabbit. Pronghorn elements (n = 47) dominate the faunal assemblage throughout the Middle Precontact period strata. Percentages for the proportion of pronghorn to bison range from 75-77 % for pronghorn to 15-16 % for bison (Keyser and Davis 1984:39; Keyser and Wettstaed 1995:19). From the 1980 excavation the remains of five individual animals were recovered from Stratum 11 (Keyser and Davis 1984:39). Parts of at least three individual pronghorn, based on 3 right astragali, were also recovered in 1991 (Keyser and Wettstaed 1995:20).

In addition to pronghorn faunal remains, a small spatulate object of worked pronghorn bone was also recovered from Stratum 8 (Keyser and Davis 1984:29). This artifact consists of "a small flat splinter of an antelope-sized metatarsal shaft fragment...[that has] been carefully shaped into a small spatulate object" (Keyser and Davis 1984:30). The function of this artifact is unknown, but in planview it resembles the small, narrow blade of a metapodial flesher (Keyser and Davis 1984:30). However, due to the fact that it has neither teeth nor a sufficiently sharp edge, along with its generally gracile nature, indicates that it was not used for heavy-duty tasks, thus placing the flesher explanation in question.

Most of the pronghorn elements recovered (68 %) represent the appendicular skeleton (Keyser and Wettstaed 1995:21). Therefore, according to Keyser and Wettstaed

(1995:21), it appears that the McKean Phase people had a procurement strategy that involved returning forelimbs and hindlimbs to the camp, while leaving most of the rest of the skeleton at the kill location. "These data, when coupled with the number of animals killed, suggest that communal procurement techniques were used to hunt antelope at a kill site relatively close to Lightning Spring" (Keyser and Davis 1984:40). "Since antelope are small enough, once dressed out, that a single hunter can carry the whole carcass back to camp, this suggests a communal kill scenario where the number of carcasses was so great that it was necessary to butcher them away from the site and transport only select pieces back" (Keyser and Wettstaed 1995:21).

Keyser and Wettstaed (1995:26) based the seasonality of the Lightning Spring lower strata on the interpretation that communal hunting strategies were used to procure the pronghorn. Therefore, "During the summer...does with fawns and some older males form nursery herds...these herds would probably be most easily exploited using communal procurement techniques" (Keyser and Davis 1984:46). If this were in fact the case, then the assumption of a summer or early fall occupation would seem appropriate for these lower strata (Keyser and Wettstaed 1995:26).

While pronghorn were the most frequently represented species in the Middle Precontact period strata, they were not necessarily the most important meat source (Keyser and Davis 1984:40). The reason for this is that bison contain a much greater amount of useable meat per animal than do pronghorn. Brumley (1975:78, 129) reports that useable meat on a bison ranges from 180 to 400 kg (an average of 290 kg), while useable meat from a pronghorn averages 25 kg. Therefore, a single bison would provide approximately as much meat as 8-15 pronghorn, so that even a single bison from any of

the archaeological strata would have provided more meat than all the recovered pronghorn. Nevertheless, "it is obvious that pronghorn were a focal point of these hunters' efforts, and had an important place in the subsistence economy of these McKean Phase people" (Keyser and Wettstaed 1995:21).

3.2.2.2 39FA23 (Communal Procurement)

This site is located in the Southern Black Hills of South Dakota, and is situated on a low terrace along the left bank of Horsehead Creek, an intermittent tributary of the Cheyenne River (Lippincott 1996:1). The radiocarbon dates of 720 ± 70 B.P. (WIS-1815), 860 ± 90 B.P. (Beta-43003), 600 ± 50 B.P. (Beta-43004), and 710 ± 60 B.P. (Beta-43005) indicate that the site dates to the Late Prehistoric Period (Lippincott 1991, 1996:40-43). In addition, the site has been interpreted by Lippincott (1996), as a multi-component Late Prehistoric, pronghorn hunting camp. The site consists of five cultural layers with numerous unlined hearths, postmolds and middens which are in association with potsherds, lithic debitage, as well as lithic and bone tools, ground stone tools, thermally-altered rock, shell ornaments and a significant quantity of faunal remains (Lippincott 1996:22-25).

The most abundant species recovered was pronghorn (85 %) with a minimum number of individuals calculated at 15 mature and 6 immature animals (Lippincott 1996:24-25; Lippincott and Byrne 1996:68; Wheeler 1995:128-129). This is based on 776 identifiable pronghorn elements. The second most abundant species was bison (6 %) with a minimum number of individuals calculated at 3 mature and 2 immature individuals (Lippincott 1996:25; Lippincott and Byrne 1996:68).

Although the pronghorn to bison ratio is 6:1, "based on the minimum number of individuals present, bison could have provided significantly greater amounts of usable meat than pronghorn" (Lippincott and Byrne 1996:72-76). "However, if the bison were available in large numbers, it would seem reasonable that they would have been the preferred prey. Pronghorn could have been viewed as a less desirable alternative or they could have been selected for qualities such as prime fall hides or merely because they were more readily available" (Lippincott and Byrne 1996:77). This species bias noted in the faunal assemblage is believed to further indicate either bison were not present, in the area, at the time of the camp or that they were butchered/processed at some other location. Either way pronghorn represents the primary prey objective of the occupants of this camp. Looking at the larger picture this site may indicate a "changed tradition from bison to antelope procurement because of extreme food scarcity brought on by stresses from local conditions, changes in bison migratory patterns and/or climatic events" (Lippincott and Byrne 1996:76-77).

In addition to fragmented and identifiable pronghorn remains, numerous pronghorn elements were found that had been reworked into bone awls. These bone artifacts, when added to the assemblage of lithic perforators and scrapers, provide evidence of the procurement of pronghorn for their hides.

According to Lippincott (1996:104), 39FA23 has all of the hallmarks of being a dated, ceramic bearing, pronghorn camp of Middle Missouri villagers on a hunting foray to the vicinity of the southern Black Hills. However, according to Sundstrom (2000:128): "More likely, this site belongs to an earlier group [of Cheyenne] using the area for seasonal hunting expeditions.

3.2.2.3 39FA83
(Communal Procurement)

Site 39FA83 was located in southwestern South Dakota, in the Angostura Reservoir basin, on the south side of the Black Hills (White 1952). Features included 35 unprepared hearths, three midden deposits consisting largely of bone scrap, and what was interpreted as a sweatlodge floor (Wheeler 1995:154).

The faunal assemblage of this Late Prehistoric period campsite "is predominantly antelope with some bison, and very little else" (White 1952:337). There were 1649 pronghorn elements in total with the greatest number of individuals represented by any one element being 48 (Wheeler 1995:188). The site also contained the remains of at least 13 bison as well as some small mammal and bird remains. "The presence of awls and hide-processing tools at this site, together with pronghorn bones from which beads were being manufactured, suggests the pronghorn were being used for clothing and ornaments, as well as for food (Sundstrom 2000:127).

In addition, this site is significant in that White (1952) selected 39FA83's pronghorn faunal assemblage, along with that of 39FA23, as samples for his influential research into the archaeological patterns created by various butchering techniques. "The antelope material was selected for this study because the entire animal could be brought to the designated spot outside the camp at which the women would do the butchering, and the elements found in the excavation represent the parts of the animal used for food" (White 1952:337). Based on White's (1952) analysis a number of patterns are highlighted as to what elements and breakage patterns should be visible archaeologically at a campsite where entire pronghorn carcasses are being brought back to be butchered, processed and utilized.

3.2.3 Wyoming

3.2.3.1 Agate Basin, Sheaman Locality (48NA211) and Agate Basin Site (48NO201) (Small-Scale Procurement)

The Sheaman site is located along the Wyoming-South Dakota border, approximately 200 m northeast of the Agate Basin site, near the divide between Moss Agate Creek and the Cheyenne River. The *in situ* Clovis cultural materials at this site lay in the bottom of what was at that time a small swale or arroyo (Frison 1982b:156). Site evidence suggests the remnant of a small campsite in the bottom and slopes of a small arroyo (Shaw and Frison 1979). A partial mandible from a bison calf suggests a spring or summer occupation (Frison 1982b). Charcoal recovered from a natural fire that postdates the Clovis occupation by 1000 years, has been dated to 10,100 ± 2800 B.P. (RL-1000), and 10,140 ± 500 B.P. (RL-1241), Therefore, the Sheaman site dates to approximately 11,000 years B.P. (Frison 1982b:147; Shaw and Frison 1979).

Associated with the other Clovis cultural material excavated to date was a unique bone tool. According to " (Frison 1982b:156) a "pronghorn (*Antilocapra americana*) metatarsal was cut in two, a short distance from the proximal end. The cut was accomplished with two directly opposing V-shaped notches that reach nearly to the cancellous bone on both sides, and then separation was completed by breaking the remainder of the bone."

Located in the same general area as the Sheaman locality, the Agate Basin site is interpreted as a seasonal camp at which bison (*Bison bison antiquus*) or (*Bison bison occidentalis*) procurement and utilization was emphasized (Frison and Stanford 1982:2).

The site has a stratigraphic record which spans slightly over 10,000 years of occupation, based upon a sequence of 18 radiocarbon dates which yielded early and terminal occupations of 11, 840 ± 130 B.P. (I-10899), and 1520 ± 140 B.P. (RL-1419), respectively. There were at least six pronghorn represented in the Clovis, Folsom, and Agate Basin components (Frison and Stanford 1982:179).

"Bison and pronghorn were the two species most extensively utilized [at the Agate Basin site], mainly for food" (Walker 1982b:307). Pronghorn remains were present in the Folsom level as well as the Agate Basin and Hell Gap levels, with the majority of the remains coming from the Folsom level (Hill 1994). The dates associated with the Folsom level at the Agate Basin site include:10,780 ± 120 B.P. (SI-3733) (area 2 hearth charcoal), 10,665 ± 85 B.P. (SI-3732) (top of Folsom level Area 3), and 11,450 ± 110 B.P. (SI-3734) (strata below Folsom level) (Frison 1982a:179).

A minimum of four pronghorn individuals were present in the Folsom faunule, based on either four occipitals or four right humeri (Walker 1982a). The investigators proposed that these particular animals were killed away from the site through individual efforts (Walker 1982a:270, 273).

Extensive cultural modifications were present on all the pronghorn material recovered. Modifications presumably resulted from the complete butchering and breakage of the bone for maximum utilization of the food resource. Most butchering evidence consists of breakage either from initial dismemberment of the carcass or marrow processing; few cut marks remain due to moderate bone surface erosion. Pronghorn procurement at Agate Basin had to have been different from that proposed for bison (Hill 1994). Evidence for this comes in the form of a unique assemblage of

organic projectile points. "What appear to be bone and antler projectile points were recovered in the Folsom component at the Agate Basin site although in exactly what context they were used is not known (Frison and Zeimens 1980) since it is not believed that they would have been effective in killing bison. However, pronghorn remains were found in the same context as the bison bones and such a projectile may have been effective against these smaller animals" (Frison 1991a:51). For a detailed inventory of the pronghorn remains at the Agate Basin site see Walker (1982b:295-296).

3.2.3.2 Austin Wash Site (48UT390) (Small-Scale Procurement)

The Austin Wash site is located approximately 24 km southwest of Granger, Wyoming in the southwestern portion of the Green River Basin (Lubinski 1997:226). The site is situated on a sandy, sagebrush and grass-covered bench at an elevation of approximately 1954 m (Reiss and Walker 1982:2-4).

Initially, the site was recorded in 1980 by Colorado State University as part of a pipeline survey (Collins and Jenning 1980). The site was located (Nelson and Bleacher 1980) and test excavated in 1980 and 1981 (Reiss and Sanders 1982) for the same pipeline project. During the survey numerous artifacts were observed on the surface including thermally-altered rock and lithic debitage concentrations, as well as lithic tools scattered over a 500 X 200 m area (Reiss and Sanders 1982). The most significant feature in the site was a shallowly-buried bone and lithic artifact midden up to 40 cm thick situated within loose sandy loam and overlying a hard-packed clay (Reiss and Sanders 1982). Although a variety of diagnostic artifacts and a range of radiocarbon ages were recovered, the midden was associated with a date of 1140 ± 80 B.P. (Beta-

3325) (Lubinski 1997:228). This date would place the site within the Late Prehistoric period.

Analyses of the faunal material indicated an assemblage dominated by pronghorn (96 % of total Number of Identified Specimens [NISP]), with at least three individuals represented (Reiss and Walker 1982:15). Based on one juvenile mandible, the seasonality of the bone bed was estimated as late November to early February (Lubinski 1997:228; Reiss and Walker 1982:17). The pronghorn remains were highly fragmented, had butchery cut marks on 23 fragments, and had an under-representation of vertebrae and ribs (Lubinski 1997:228). This indicates a fairly intense utilization of the pronghorns. "It is suggested that the animals were skinned, dismembered, and the meat was removed from the bones and possibly roasted. The bones were cracked for marrow and further reduced and cooked for their grease content" (Reiss and Walker 1982:23).

The site was more thoroughly excavated in 1983 due to another pipeline project (Schroedl 1985). The focus of the 1983 excavations was a 90 square metre block of the bone midden, which was identified in the earlier excavations. Excavations revealed 10 pit features and 4 postmolds in the midden area, and yielded a single metate fragment plus 21,000 pieces of lithic debitage, 16,000 faunal remains, and 700 curated lithic tools (Lubinski 1997:229). The midden was composed of bone, thermally-altered rock, lithic flakes, and charcoal scattered throughout the main excavation area (Schroedl 1985).

Diagnostic artifacts recovered from the midden were limited to a single late Paleoindian Lovell Constricted point, suggesting mixing of sediments, and 16 Late Prehistoric Rose Springs projectile points. Two radiocarbon samples directly associated with the midden yielded dates of 1250 ± 60 B.P. (Beta-7272) and 1160 ± 50 B.P. (Beta-

7273) (Lubinski 1997:232). The absence of articulated bones, as well as the diversity of artifacts and high frequency of features prompted the excavators to conclude that the midden represented a processing locale rather than a kill or primary butchering location.

Faunal analysis of the midden excavation (Schroedl 1985) indicated an assemblage dominated by pronghorn (93 % of identified fragments) representing at least 15 individuals (Lubinski 1997:233). The faunal assemblage is indicative of a late fall to early winter season of death (Lubinski 1997:237). This seasonality estimate is not significantly different from the estimate made by Reiss and Walker (1982).

In general, the faunal discussion closely matched those from the earlier excavation (Reiss and Sanders 1982), with the exception that no body parts appear to be under-represented using this larger sample. However, the age distributions are dominated by mature individuals (Lubinski 1997:287), which is inconsistent with herd composition during the season of mortality.

In summary, the archaeological evidence at Austin Wash is not consistent with a single mass kill event (Lubinski 1997:242). Although there are no compelling indications of non-human mortality or multiple seasons of mortality, the weathering data and presence of a Paleoindian point in the bone bed indicate there may be multiple depositional episodes. This is supported by one of the two available age distributions suggesting that more adult animals are present than expected for a randomly-selected pronghorn population (Lubinski 1997). Therefore, Lubinski (1997) concluded that Austin Wash represents the processing of pronghorn procured during numerous small-scale hunting episodes, rather than during a single mass kill.

3.2.3.3 Boar's Tusk Site (48SW1373) (Small-Scale Procurement)

The Boar's Tusk site lies in the Green River Basin, approximately 40 km north of Rock Springs in southwestern Wyoming (Fisher and Frison 2000:90). Situated at an elevation of 2040 m, this Late Prehistoric or Protohistoric short-term campsite consists of 11 dwelling or shelter features, in addition to numerous stone and bone artifacts (Fisher and Frison 2000).

The recovered artifacts included 16 projectile points (of which 15 are tri-notched arrow points), 11 other flaked stone tools, a mano, several hundred pieces of lithic debitage, 4 bone beads, and faunal remains (Lubinski 1997:280)

This site was dated using both diagnostic projectile point analysis (n = 16) and radiocarbon dating. "All projectile points are small, triangular arrow points diagnostic of the Late Prehistoric period or in the Protohistoric period" (Frison 1991a:116). In addition, a charcoal radiocarbon date from Feature 2 indicated an age of 100 ± 80 B.P.(Beta-88934) (Fisher and Frison 2000:90; Lubinski 1997:280). "Based on the site location, tri-notched points, and late age, the site might reasonably be attributed to a Numic group, presumably the Eastern Shoshone" (Lubinski 1997:280).

Pronghorn dominates the archeofauna numerically, representing the remains of six individual animals (Lubinski 1997:280). Based on pronghorn dentition samples the occupation is estimated to have taken place between mid to late fall and mid winter, with the majority of the evidence pointing to sometime during November-December (Fisher and Frison 2000:90; Lubinski 1997:). Most of the available evidence is consistent with multiple depositional episodes of bones at Boar's Tusk (Lubinski 1997:286).

Pronghorn remains were found in each of the five excavated features, however, not all skeletal portions were equally represented (Lubinski 1997:280-281). A strong contrast exists between the frequency of axial elements and those from the appendicular skeleton. Two explanations could account for this difference. "First if the pronghorn had been killed elsewhere, selective transport of limbs in favor of axial elements (except skulls) from the kill site(s) to the Boar's Tusk site could result in the observed element frequencies. Second differential destruction of skeletal elements at the Boar's Tusk site, either by human activities or by natural processes such as weathering and decomposition, could have eliminated more axial elements than appendicular bones" (Fisher and Frison 2000:95). The small size and consequent ease of transporting a pronghorn carcass with minimal primary butchering might diminish the probability of selective transport (Fisher and Frison 2000:95).

A large portion of the bone fragments are calcined and an additional 101 elements display lithic tool cutmarks (Fisher and Frison 2000:93). "It is not clear whether bones at Boar's Tusk site became calcined as a result of purposeful heating by the site occupants (e.g., during cooking), or from casual discard of bones into fires, or from lighting a fire where bones had previously been deposited" (Fisher and Frison 2000:93). The activities probably responsible for the cutmarks include skinning, muscle stripping, and joint dismemberment (Fisher and Frison 2000:93).

One interesting characteristic of the pronghorn assemblage at Boar's Tusk is the small number of individual animals represented cumulatively at all five excavated features. "The small number of pronghorn at Boar's Tusk suggests that site occupation

was brief" (Fisher and Frison 2000:94). The small quantity of artifacts recovered is consistent with this interpretation.

3.2.3.4 Bridger Antelope Trap (48UT1) (Communal Procurement)

The remains of two aboriginal pronghorn traps, one made of juniper the other of sagebrush, are still visible in southwestern Wyoming adjacent to the town of Fort Bridger (Frison 2004:135). One trap is located in a faulted area characterized by alternating hogback ridges and narrow, flat valleys. The other trap is strategically located between two playa lakes. In Wyoming playa lakes are a common feature in flat areas and are preferred places for pronghorn to gather, especially after late summer rainstorms have rejuvenated dry summer grasses.

Referred to as the Fort Bridger pronghorn trap this procurement complex covers an area of approximately 520 by 213 m or about 11 hectares (Frison 1991a:242). The corral is oval shaped, roughly 200 by 150 m. One end of the oval is open and a long curving fence forms a drive line approximately 625 m in length (Figure 3.2) although there is an apparent interruption in the fence through tall sagebrush for approximately 100 m (Frison 1991a).

An exposed area, outside the enclosure, was almost certainly a camp or processing area as it yielded Late Prehistoric-type projectile points, lithic tools, and a few badly deteriorated bone fragments; however, no historic artifacts were recovered (Frison 2004:133).

The remaining fences are constructed of juniper. According to local residents the fence was originally several feet high. The missing section may have been constructed

Unfortunately, the juniper part of the fence was an excellent source of firewood for early settlers in the area and much of it was removed for that purpose, leaving only enough for the outline of the trap to be traced. A few better preserved sections of the fence suggest that it was around 1.3 m to nearly 2 m high and approximately 1 m wide at the base (Frison 1991a:242). There is an indication that part of the fence was abandoned and rebuilt at a slightly different location. However, this could have been deliberate with one part of the fence used to get animals into the trap and the other for circling the animals. "A definite anomaly in the north end of the fence was likely a shaman's structure but it was too badly deteriorated ... to determine its exact configuration" (Frison 1991a:244).

The exact age of the trap is not known; however, the environment is arid and juniper preserves reasonably well, therefore, a date in excess of 200 years is reasonable. A similar site, located in the same general area, was made of sage brush and has completely disappeared. However, at least one early resident of the area was reported to have made the claim that he had seen the latter trap in operation sometime well before the turn of the century. Details of the operation were not elaborated but the fact that it was a functional pronghorn trap in historic times seems certain (Frison 1991a:244).

This procurement complex was entirely adequate to trap and contain pronghorn; however, it would have been worthless for trapping either deer or bison. The former would have simply gone over the juniper fence and the latter would have gone through it (Frison 1991a).

of sagebrush since it was easily available and has simply rotted away (Frison 1991a, 2004).

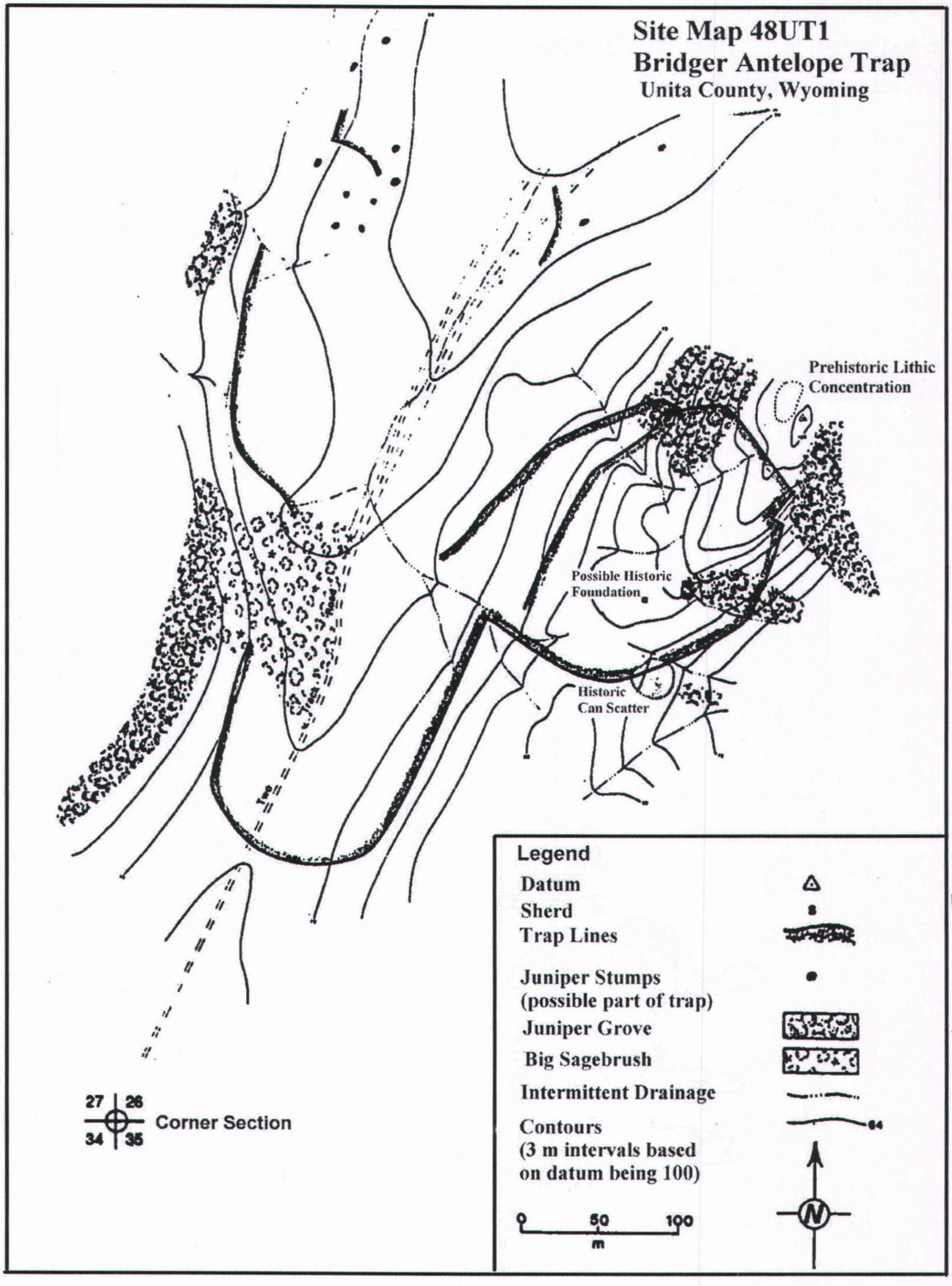


Figure 3.2 Site map of Bridger Antelope Trap (Frison 2000b:35)

3.2.3.5 Casper Site (48NA304) (Small-Scale Procurement)

The Casper site is a parabolic sand dune bison trap, similar to the Agate Basin site, and has been interpreted as a late fall episode seasonality. Several radiocarbon dates were derived from charcoal and bone samples and the results range from 9830 ± 350 B.P. (RL-125) to 10,060 ± 170 B.P. (RL-208) (Frison 1974b:108). These dates are in line with other dates on Hell Gap cultural levels including those from the Sister's Hill site.

What makes this site really unique is the fact that it contained diagnostic pronghorn bone from a Hell Gap context (Frison 1974b:108). Two specimens were recovered, NC 2559, an ascending ramus from a right mandible and a proximal phalanx (Wilson 1974:131). Of additional interest is the fact that pronghorn remains are not uncommon at Paleoindian kill sites and often display evidence of butchering. Examples include the Horner (Walker 1987), and Colby site (Frison and Todd 1986), in addition to several of the Paleoindian sites mentioned in this chapter.

3.2.3.6 Eden-Farson Site (48SW304) (Communal Procurement)

The Eden-Farson site is located approximately 10 km east of Eden, Wyoming in the north-central portion of the Green River Basin (Lubinski 1997). It is situated within a rolling landscape of sagebrush and bunchgrass-covered stabilized sand dunes along the margin of the Killpecker Dune Field at an elevation of 2033 m (Frison 1971b).

On the surface of the site there are concentrations of thermally-altered rock, bone and lithic material extending over at least a 100 by 150 m area (Lubinski 1997:254). Frison (1971b) initially excavated 28 exploratory units and evidence from these units indicated

a single occupation level with intensive rodent disturbance (Larson et al. 1969). The discovery of shallow postholes with charred juniper provided evidence for what appeared to be discrete dwelling structures. In total, 12 oval to circular lodges with dimensions of up to 4.6 by 6.1 m were excavated, each containing a fire pit, heat-altered rock concentrations, bone midden, lithic work areas, and three or more post molds (Frison 1971b).

In addition to heat-altered rock and lithic debitage, 401 projectile points (the majority tri-notched), a large number of other lithic tools, several shell beads, a number of bone tools and ornaments, two steatite pipe fragments, and fragments of Intermountain Ware vessels were recovered. This artifactual material has been summarized in Frison (1971b), Larson et al. (1969), and Lytle (1969). Several of the bifacial knives recovered from the site were later recognized as "Shoshone knives" (Frison 1991a:133).

A radiocarbon date of 230 ± 100 years B.P. (RL-101) (Frison 1971b) suggests either a late Late Prehistoric or early Protohistoric occurrence (Frison 1987:199) although no historic items were recovered. Frison (1971b) and Lubinski (1997) conclude that the ethnicity of the Eden-Farson site can be attributed to a Shoshonean group. "The Eden-Farson site is almost certainly of Shoshonean origin" (Frison 1991a:244). This is based on the site location, flat-bottomed flanged-base ceramics (Intermountain Ware), remains of wickiup-like structures, remains of insects and seed cakes, a steatite elbow pipe of a European style but broken during manufacture, and the presumption that the site represents a communal kill (Frison 1971b:258). In addition, all the site activities were accomplished with stone and bone tools (Frison 1991a:244).

Faunal analyses were completed by Frison (1971b) and Nimmo (1971) and revealed an assemblage dominated by pronghorn (95%), with an MNI of at least 212 pronghorn (Frison 1971b). Frison (1971b:281) notes that more bone was probably present at the time of deposition, but that some of it has likely been carried away by scavengers or has decomposed.

Nimmo (1971) did an analysis of the pronghorn assemblage's age structure, based on mandible data. This revealed an ambiguous mortality profile and discrete, evenly spaced age classes, which indicates cohorts that died in a single event (Nimmo 1971). Nimmo's (1971), study also concluded that all the pronghorn had been killed in a short period of time between late October and early November. It is believed that these data represent strong evidence that this pronghorn assemblage is the result of communal rather than individual or small group procurement (Frison 1987).

The Eden-Farson site represents a winter encampment where pronghorn were the major food source for the prehistoric occupants (Frison 2000a, 2000b). The condition of the faunal remains suggests that the pronghorn carcasses were being utilized as thoroughly as possible (Frison 1971b:261). The site yielded evidence for the use of boiling pits that may have been used in the process of rendering pronghorn bone in order to extract grease (Frison 1971b:260-270). Frison (1991a) indicates that this assemblage provides indirect evidence of pronghorn trapping in the Green River Basin.

The existence of a trap was postulated on the grounds that only a trap could have enabled the hunters to take so many animals in such a short time (Frison 1971b, 1991a). Of several possible ways the animals could have been trapped, one seems more feasible than the others. The site area is characterized by ridges of sand 6-9 m across, 1-1.5 m

high, and several hundred metres long, presently stabilized by big sagebrush up to 2 m high (Frison 1991a:244). In more than one location, the sand ridges form nearly complete outlines for suitable corrals and the hunters could easily have constructed a brush fence by pulling and piling the sagebrush (Frison 1991a). It is known from eyewitness accounts that sagebrush corrals a metre or slightly more in height are sufficient for holding pronghorns (Frison 1991a:244).

It has been noted that carnivore modification, as well as butchering marks, are present on the pronghorn remains. This creates a "compelling explanation ... that [the] carnivore modification is the result of camp dogs or post-abandonment ravaging, given the high proportion of mandibles with butchery marks" (Lubinski 1997:261).

Frison (1991a) believes that the evidence of pronghorn butchering and processing present at the Eden-Farson site indicates a stylized process. The bones demonstrate similar breakage patterns and the skeletal remains strongly indicate intense utilization of all animal parts although many skeletal parts are missing in the site deposits, leaving many details of carcass treatment in question (Frison 1991a). However, treatment of skulls in the butchering process is of some interest. These were removed by cutting directly backward from the rear corners of the mouth through hide and muscle leaving unmistakable cut marks (Frison 1971b:264). The mandible was then unhinged by a sharp downward pull. Cut marks indicate that the neck muscles were cut and the skull was removed with a quick twist. All bones were crushed and broken for marrow extraction and probably cooked in ceramic vessels to obtain bone grease (Frison 1991a:245).

The number of animals taken in such a short period suggests surpluses, which were probably dried for later use. The lodges were preserved because they were located just

over the leeward edge of a flat-topped, mesa-like landform and sand drifted over the edge so that in places the site was covered up to 40 cm deep. A favorable location for meat drying would have been on top of the mesa where bones and other perishable evidence would have been lost (Frison 1991a:245).

Although the number of pronghorns killed at the site sounds impressive, as noted in Chapter 2 the carcass size is not very large. "There were undoubtedly many more than the 212 animals recorded but this number could have produced at least 2700 kg of flesh in addition to parts such as heart, liver, brains, and bone grease" (Frison 1991a:245). If the other animals and edible plant remains, which were found at the site, were added to the total mentioned above, then there was more food than the group (estimated at about 75) could have eaten before spoilage (Frison 1991a:245). Frison (1991a), makes a strong argument that some of the meat was dried for later use.

Lubinski (1997) undertook a reanalysis of the faunal material as Frison (1971b), Nimmo (1971) and Lyman's (1987) interpretations of the initial age profile differ significantly. Frison (1971b:266) initially interpreted the profile as catastrophic, while Nimmo (1971:287) interpreted it as between catastrophic and attritional. Finally, Lyman (1987:127) interpreted the profile as attritional. Lubinski's (1997:263) research indicates that the season of mortality was most likely early April to early October, and the assemblage is representative of a single mass kill. It should be noted that the Eden-Farson faunal assemblage has not been closely examined in its entirety, and additional faunal work or radiometric dates could provide evidence that the lodges are not contemporaneous. If the lodges are found not to be contemporaneous then the single kill hypothesis would be void. "However, based on the currently available data, Eden-Farson

is considered more consistent with a single mass-kill event than with alternatives" (Lubinski 1997:269). These conclusions are consistent with those drawn by the principal investigation conducted by Frison (1971b) and Nimmo (1971).

Regarding the Eden-Farson site, Frison (1971b:282) believes that it represents a habitation location utilized by a Shoshonean group oriented toward a Great Basin rather than a Plains cultural pattern, with little possibility that the site has any connection with the Plains-oriented, horse period, bison hunting Shoshone.

3.2.3.7 Firehole Basin #11 (48SW1217) (Communal Procurment)

Firehole Basin #11 is located approximately 16 km southwest of Rock Springs, Wyoming in the south-central portion of the Green River Basin (Lubinski 1997:242). The site lies on a hill overlooking Little Bitter Creek in the uplands between the creek and the Green River. The site is located at an approximate elevation of 2073 m over sandy sediment interspersed with sagebrush and juniper vegetation (Lubinski 1997).

The site was initially recorded during a 1976 coal sampling survey by a crew from Western Wyoming College (Metcalf 1977). Old juniper logs on the surface suggested remnants of a corral structure (McGuire 1976; Metcalf 1977), but no formal investigation of this feature has been conducted. To date the only archaeological work done on the site are the 1976 and 1977 test excavations. This work consisted of 34 1 X 1 m, test units excavated as a Western Wyoming College archaeological field school. Information on this work is available from a number of sources (Davis 1977, 1978; Lubinski and Metcalf 1996; Metcalf and Treat 1979; McGuire 1976; Reiss and Walker 1982).

In addition to the recovery of pronghorn remains from a shallowly buried bone midden, the excavators found a number of charcoal stains, a possible postmold, lithic flakes, ground stone and ceramic artifacts (Lubinski 1997:243). Of these the diagnostic artifacts include grayware ceramics, small tri-notched projectile points, and hafted "Shoshonean" knives, all of which indicate a Late Prehistoric to Protohistoric affiliation.

Two radiocarbon dates, 625 ± 50 B.P. (UGa-2049) and 645 ± 135 B.P. (UGa-2048), agree with this conclusion. In fact, the one-sigma calibrated age is AD 1290-1410 (Lubinski 1997:245). Although this site is not well known, it is one of the few sites in the Green River Basin dating to this time period. As such, Metcalf (1987) named the terminal prehistoric period in the Wyoming Basin the "Firehole" phase.

Preliminary faunal analyses were undertaken in the late 1970s and reported by Metcalf and Treat (1979). These analyses revealed a bone assemblage dominated by pronghorn and thought to include a minimum of 37 individuals. Lubinski (1997), undertook a more formal faunal analysis of the Firehole Basin material and found that "there is good evidence for human use of the pronghorn based on ... butchery cut marks and green breakage of the bone" (Lubinski 1997:247). Evidence for human involvement is excellent; conversely there is no evidence indicating a natural role in mortality, such as a nearby natural trap, or high degree of element completeness.

Lubinski (1997:249) concluded that the evidence strongly supports a single depositional episode, occurring sometime in December or January. "The Firehole Basin annual age distribution is consistent with either catastrophic or attritional mortality, but not with adult or prime-dominated mortality" (Lubinski 1997:253). Evidence recovered

is consistent with a single mass kill rather than an accumulation of small kills or natural deaths (Lubinski 1997).

3.2.3.8 Gailiun Site (48SU1156) (Small-Scale Procurement)

This Wyoming site is located in the northeastern Green River Basin and lies on an alluvial silt terrace adjacent to Dry Sandy Creek. Situated at approximately 2143 m, the site is currently covered by a sagebrush-grassland vegetative community (Current 1993).

The site was first excavated in 1978 by the Western Wyoming College (WWC) archaeological field school under the direction of Love (Lubinski 1997:270). Four 2 X 2 m units were excavated within a single artifact concentration (Love 1978). "The four units yielded scattered cultural materials, concentrations of bone, soil stains, and a large "charcoal mash" roughly 200 X 180 cm in size" (Lubinski 1997:271).

A radiocarbon date run on the charcoal yielded a date of 150 ± 60 B.P. (Beta-36433). The temporal affiliation of the site is Late Prehistoric to Protohistoric based on the radiocarbon date, plus the recovered tri-notched, side-notched, and Cottonwood triangular projectile points, and Intermountain Ware ceramics (Lubinski 1997:273). Based on the site location, projectile point types, ceramic type and late age, the site can reasonably be attributed to a Numic group, presumably the Eastern Shoshone (Lubinski 1997:273).

The site was revisited in 1990 by Current, then at WWC's Archaeological Services (Current 1993). Current observed five artifact concentrations located in shallow depressions, which he believed to represent the remains of five structures (Lubinski 1997). "Each of these depressions was five to nine metres in diameter, and filled with bone, chipped stone, fire-cracked rock, and ceramics" (Lubinski 1997:271). Lubinski's

(1997) study represents the first formal analysis of the Gailiun site faunal material. His research indicates that a minimum of 8 pronghorn are represented in the sample based on landmarks and taking age into account. No direct evidence as to the cause of the death of the pronghorn is indicated; however, there is strong evidence for the human use of the pronghorn, based on the abundance of butchering marks (Lubinski 1997:274-275).

Site seasonality is estimated to be between late August and late January and the age distributions are indicative of more than one mortality event (Lubinski 1997). Based on this evidence Lubinski (1997) indicates that this site's pronghorn assemblage is most likely the result of numerous small-scale hunting episodes.

3.2.3.9 Glenrock Buffalo Jump (48CO304) (Small-Scale Procurement)

The Glenrock Buffalo Jump is located in central Wyoming along the North Platte River, 2 km south of Converse (Frison 1970:1). Here, bison herds were driven over an approximately 12 m high bluff, during the Late prehistoric period (Frison 1970:1). This temporal determination is based on two radiocarbon dates, 210 ± 100 B.P. (M-2350) and 280 ± 100 B.P. (M-2349) (Frison 1970:7, 1991a:35).

"Good bone preservation in much of the site allowed recovery of large samples for analysis and in addition large numbers of simple but functional tools were found in context" (Frison 1970:1). Bison comprised nearly all of the total bone, but three specimens of canid were also recovered. "Other specimens, include two metatarsals and a phalange of *Antilocapra americana*" (Frison 1970:25). These three identifiable elements combined with an additional eight unidentifiable pronghorn bone fragments indicates that a minimum of one pronghorn individual was procured (FaunMap n.d.).

In addition, "one antelope metacarpal, ground to an unusual shape (see Figure 3.3 below), may have been a tool for gouging marrow out of bones" (Frison 1970:30). The remaining non-bison fauna includes jackrabbit, cottontail rabbit, badger, weasel and bird bones. These "bird bones include those of a single *Anseriformes* or probably a mallard duck" (Frison 1970:25).

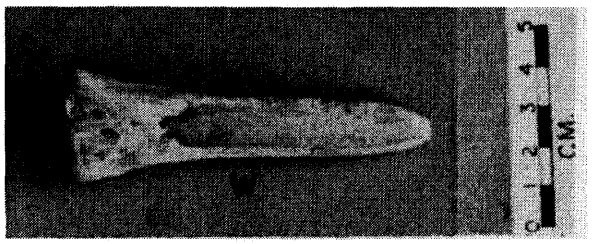


Figure 3.3 Glenrock Buffalo Jump bone tool made from a pronghorn metacarpal (Frison 1970:32)

The presence of non-bison remains in a bison communal kill bone bed is far from uncommon, however, it makes one ask why? With so much meat procured why was a single pronghorn needed?

Danny Walker, (personal communication 2004) states "that it was not uncommon for a single animal to get caught up in a bison herd being driven and ending up in the kill assemblage." He mentioned the example of the camel in the Casper site bison bone bed as further evidence of this phenomenon. George Frison (personal communication 2004) mentioned rounding up cattle and finding several deer intermixed with them in the corral. Perhaps, therefore, the pronghorn simply become a fatality of the kill episode by being caught up with a stampeding bison herd. A symbiotic grazing relationship exists between pronghorn and bison. This would place pronghorn and bison together when the buffalo runners began to move the herd towards the drive lanes. Although the herd instinct is not as strong with pronghorn as with bison, it seems possible, that during a

bison stampede pronghorn individuals that had been grazing with the selected bison herd might attempt to flee along with these animals, at least for a short distance. In most cases they would have been able to extract themselves from the stampede, unless they were caught within the line of drive lane hazers and forced forward by the momentum of the larger bison.

3.2.3.10 Hawken Site (48CK303) (Small-Scale Procurement)

The Hawken site is an early Plains Archaic period arroyo bison kill, located in the Wyoming Black Hills. Although "no camp, butchering, or meat processing areas were found" (Frison 1991a:86), the artifact assemblage is nevertheless quite extensive. Of specific interest to this research was the recovery of a unique bone tool.

"The distal end of an antelope metatarsal (*Antilocapra americana*) was [found] modified into a knapping tool" (Frison et al. 1976:53). It is not known if the animal was procured for meat, and the element utilized from the carcass or if the element was simply salvaged from the prairie landscape.

Radiocarbon dates of 6270 ± 170 B.P. (RL-437) and 6470 ± 140 B.P. (RL-185), substantiate the early Plains Archaic period placement for this site (Frison 1991a:32).

3.2.3.11 Little Missouri Antelope Trap (48CK49/69) (Communal Procurement)

The remains of a historic pronghorn pit with drivelines and corral were first reported from the headwaters of the Little Missouri River in northwestern Wyoming in 1975 (Frison1991a:245, 2004:135-136; Tratebas 2003). Subsequent survey was carried out in 1990 and again in 2002 (Tratebas 2003) with local residents identify the fragmentary V-winged juniper fences and corral as a pronghorn trap (Frison 1991a:245).

The trap is located on a small ridge at the confluence of two branches of the Little Missouri. The basin is on the northwest slope of Cedar Ridge and lies between two fingers of the shale ridge (Tratebas 2003). Placement of this procurement complex took advantage of a natural pass over Cedar Ridge. The pronghorn were apparently diverted into the pit after entering the pass (Sundstrom 2000:125).

Unfortunately, much of the juniper was removed for firewood during the historic period, but the remains of wings and a three-sided, log-lined 2 X 3 m pit "appearing like an abandoned cellar" (Lubisnki 1997:71) were still visible in 2002 (Tratebas 2003:2). "In places several sets of wings are parallel to each other, likely from rebuilding and reusing the trap many times (Tratebas 2003:3).

The 2002 survey located a number of camp sites and isolated lithic artifacts that suggest activities associated with the trap. These artifacts include projectile points, both Late Prehistoric side-notched points and Late Archaic corner-notched points, located in both the camp sites and within the wings (Tratebas 2003:3-4). In addition, several endscrapers, most likely used for hide working, were recovered from a camp site near the pit feature (Tratebas 2003:4).

Although the cultural affiliation of this site has not been determined conclusively, the Little Missouri headwaters area were the principal pronghorn-hunting ground of the Northern Cheyenne. In fact, the Cheyenne name for this stream is Wokaihe'yunio'he, Antelope Pit River (Sundstrom 2000:126; Tratebas 2003:9). An 1878 Cheyenne map of the area uses a pronghorn glyph to label one of the southern branches of the Little Missouri (Sundstrom and Fredlund 1999). Published literature for the Cheyenne shows that this site is the location where the Antelope Pit ceremony took place (Tratebas

2003:13). In addition, "The Cheyennes believed that pronghorn were attracted by a forage plant that grew along the [upper Little Missouri] river" (Sundstrom 2000:126).

While the above evidence provides support for a Northern Cheyenne affiliation the archaeological evidence also supports a hypothesis of significant time depth and numerous reuse episodes of both the trap complex and adjacent camp locations. In addition, this site provides valuable information regarding the utilization, by native groups, of the natural topography in order to facilitate and control the movements of pronghorn herds.

3.2.3.12 Oyster Ridge Site (48UT35) (Small-Scale Hunting)

The Oyster Ridge Site (48UT35) is another Late Prehistoric butchering camp in southwestern Wyoming. "The site lies at the foot of Oyster Ridge, a prominent north-south trending hogback that extends some 97 km from north of Kemmerer to just south of Evanston" (Zier 1982:26). The site is situated at 2012 m above sea level on a west-sloping colluvial fan on the western side of the ridge, overlooking the floodplain of Albert Creek. Further west is the Little Hogsback and the Bear River Divide. The principal flora in the area is sagebrush, greasewood, rabbitbrush, saltbrush, and juniper (Zier 1982:26).

The site's dimensions are approximately 30 m north-south and 20 m east-west (Zier 1982:28). Features included a circular, basin shaped, unlined hearth in association with a variety of bone and stone artifacts. Charcoal from a hearth directly associated with the bone deposit dates the event at 1375 ± 60 B.P. (UGA-2046) (Lubinski 1997:91; Zier 1982:26).

The lithic artifacts included 518 pieces of debitage, various bifacially worked butchering tools, two complete and six broken corner-notched projectile points, a fragmented sandstone grinding slab and quartzite mano and a gaming piece. In addition, the site contained a 6 X 2.3 m bone bed yielding 1736 highly fragmented pronghorn bones and teeth (Zier 1982:28). The total volume of bone recovered argues against a large kill. The fragmentation is believed to reflect cultural activities associated with the butchering process, such as marrow and grease extraction, rather than preservation (Zier 1982:34). The site appears to be consistent with others in the region with regard to basic patterns of butchering, suggesting near-total utilization of the animals, including fracture of phalanges for grease extraction. The style of butchering at Oyster Ridge is characterized by partial dismemberment of carcasses at or near the kill site, with subsequent removal of certain parts to a camp for further processing.

The Oyster Ridge pronghorn faunal assemblage represents the remains of at least three post-natal animals, based on three left distal ends of tibiae with intact articular surfaces, and one fetal individual (Zier 1982:30). Based on the fetal development the kill occurred in approximately mid to late April. This site represents the procurement of a limited number of animals, a process that would have involved the efforts of only a few hunters who probably operated without the aid of a sophisticated trap (Zier 1982:34).

Based on the herding behaviour of modern pronghorn in April, the apparent small group of animals killed at Oyster Ridge is consistent. Spring generally brings a reduction in group size as large herds fragment into smaller, more stable bands. Will these conclusions appear justified "It should be cautioned, however, as additional remains may

lie buried at the site" (Zier 1982:30). Additionally, there is no way of determining if the site simply represents the killing of a few individuals out of a larger herd.

"The Oyster Ridge site is a short-term camp at which occupants engaged primarily, although not exclusively in butchering and further rendering of a limited number of pronghorn" (Zier 1982:34). This site compares favorably with Vehik's (1977) model of a special purpose, limited activity meat-processing camp. In fact, Oyster Ridge approximates her model: a small group of individuals occupying a limited area for a limited period of time; tools used in butchering; butchered bones and, specifically, the unmistakable evidence of bone grease manufacture: hearth, burned rock, and fragmented bone (Zier 1982:34,36). Oyster Ridge differs from other pronghorn procurement sites from the Wyoming area, in that it represents a spring kill, and is not indicative of communal procurement.

3.2.3.13 Schiffer Cave (48JO319) (Small-Scale Hunting)

Schiffer Cave is a dry rockshelter, located on the north Fork of the Powder River, approximately 29 km northwest of Kaycee, Wyoming (Frison 1973a:301). Features include storage pits and hearths (Frison 1991a:342-343) along with an assortment of lithic and faunal artifacts. Two radiocarbon dates were obtained from charcoal taken from firepits within Schiffer Cave. The results were 8360 ± 160 B.P. (RL-99) and 8500 ± 160 B.P. (RL-100) (Frison 1991a:27). These dates place this site within the excepted range for the PaleoIndian Period.

All larger bones from Schiffer Cave were broken to the extent that identification was difficult. However, "there was a single third molar of an antelope (*Antilocapra americana*) and a single first phalange from the same species" (Frison 1973a:310). In

addition, the third phalanges from three mountain sheep (*Ovis canadensis*) was recovered. Associated with the above faunal remains were a badly broken but articulated astragalus, calcaneus and a fused central and fourth tarsal along with the distal end of a metacarpal represent at least one mule deer (*Odocoileus hemionus*) (Frison 1973a:310). Several smaller mammals are also represented in the faunal assemblage (Frison 1973a:310).

3.2.3.14 Sister's Hill Site (48JO314) (Small-Scale Procurement)

Located 10 km southwest of the town of Buffalo, in Johnson County, Wyoming, the Sister's Hill site is situated at 1646m in elevation. What makes this site unique to the prehistory of the Plains is that bison remains were not recovered from this single component Hell Gap excavation (Agogino and Galloway 1965:191-192). This site was occupied during early Holocene times, as a single radiocarbon date of 9650 ± 250 B.P. (I-221) was derived from a composite charcoal sample (Agogino and Galloway 1965:192).

The charred remains of pronghorn, mule deer (*Odocoileus hemionus*), porcupine (*Erethizon dorsatum*), ground squirrel (*Citellus* spp.), and numerous other small rodents comprised the faunal assemblage of the Sister's Hill site (Agogino and Galloway 1965:192): "Apparently, the Sister's Hill Site was occupied during a season when bison were not readily available for no such bones were found at the site" (Agogino and Galloway 1965:192).

3.2.3.15 Skull Point Site (48LN317) (Small-Scale Procurement)

Skull Point is located in southern Wyoming, at approximately 2094 m of elevation, on the southernmost extent of a sandstone ridge, situated between Oyster Ridge to the east and the Bear River Divide to the west (McGuire 1977:5). "It is believed that Skull Point represents a Shoshonean camp related to the Late Prehistoric Period" (McGuire 1977:4). This tentative cultural assignment was based on the preliminary analysis of the ceramics and projectile point styles, along with the fact that the economy seems somewhat similar to that described for Great Basin groups in Wyoming (McGuire 1977:15). The radiocarbon dates that were recovered from the site, 300 ± 50 B.P. (Uga-2047) and 1375 ± 55 B.P. (Uga-2046), substantiate the Late Prehistoric affiliation (FaunMap n.d.).

Features included multiple basin-shaped hearths, a game processing area, as well as pictographs and petroglyphs. These are in association with lithic debitage and tools, including projectile points (n = 27), potsherds, ground stone artifacts, bone tools and fragmented and intact bison and pronghorn remains.

"What are presumed to be antelope bones are scattered throughout the trench and possibly represent a midden heap. The fragments have been compared with other butchered antelope bones and conform to patterns of breaks and thicknesses" (McGuire 1977:11). Due to the high degree of butchering and processing experienced by the faunal assemblage, species identification was often challenging: "The more gracile bones appear to be related to identified specimens of antelope (*Antilocapra americana*). In some locations, the antelope bone is very fragmentary and exhibits numerous cutmarks"

(McGuire 1977:9). McGuire (1977) does, however, note recovering an intact pronghorn metapodial and phalanx.

The faunal "data from the Skull Point site indicates that one or several groups of people involved in a hunting and gathering subsistence frequented the area" (McGuire 1977:14). Judging from the number of animals present, as noted by (McGuire 1977:14-15), "very few people could have existed for a short period of time based on the dietary needs of other prehistoric groups."

3.2.3.16 Trappers Point Site (48SU1006) (Communal Procurement)

The Trappers Point site is located in the Upper Green River Basin of southwestern Wyoming near Pinedale, Wyoming. The site is situated on the upper leeward side of a sagebrush-covered ridge that links a large plateau to the south with a series of hills to the north and northwest (Sanders and Miller 2004:165). The site lies at an elevation of 2226 m and is bordered by the Green River to the west and the wide meadows of the New Fork River to the east. An upland sagebrush steppe and riparian ecozone characterize this portion of the basin. As indicated by the archaeological record this region provided ideal pronghorn habitat in the past as well as the present (Eckerle et al. 1999:5).

The site is located at a geographical bottleneck. As pronghorn migrated seasonally through this constriction, they were ambushed. The Trappers Point data indicate that the movement across the bottleneck is not only a recent phenomenon, and in fact, this area continues to be utilized by modern migrating pronghorn herds (Sanders and Miller 2004).

Trappers Point is a multi-component pronghorn kill and processing site excavated by the Office of the Wyoming State archaeologist in advance of highway construction in

1992 (Francis 1999:1). A block excavation of 129 square metres, encompassing strata 3, 5 and 7, yielded evidence of three human occupations, all attributed to the early Archaic period (Miller et al. 1999).

This multi-component pronghorn kill and processing site, with an age range from 7880-2890 RCYBP and an early Archaic period bone bed date averaging 5700 RCYBP, provides the best evidence for Early Archaic pronghorn procurement in the entire area (Lubinski 1997; Miller et al. 1999; Miller and Sanders 2000:165). Charcoal samples produced radiocarbon dates ranging from 7880 ± 60 B.P. (Beta-79542) to 2890 ± 60 B.P. (Beta-55173); however the stratum 5 dates ranged from 6010 ± 130 B.P. (Beta-79197) to 5490 ± 60 B.P. (Beta-79189) (Francis and Sanders 1999:42).

The largest pronghorn bone bed that was exposed during this excavation was from stratum 5. This bone bed covers 93 square metres and consists of more than 57,000 bone specimens, primarily pronghorn or medium-ungulate sized remains. At least 27 mature and immature animals and eight fetuses were recovered from this level (Sanders and Miller 2004:164). However only 28 % of the bone bed was excavated, so the minimum number of individuals would be higher if more of the site were excavated (Sanders and Miller 2004:165).

The dentition and fetal bone indicate a spring kill, most likely mid-March or April (Berger 2004; Fenner 2004; Miller et al. 1999:206-240; Miller and Sanders 2000). Based on ontogenic age of the mandible sample most of the pronghorn were 3 years old or less, suggesting catastrophic mortality from a single event or several very closely spaced kill events (Lubinski 1997; Sanders and Miller 2004:165). Although these pronghorn remains suggest catastrophic mortality it cannot be determined whether or not the

assemblage represents a single cohort kill or several closely spaced events in a single year (Miller et al. 1999).

Strata 3 and 7 each contained the remains of two adult pronghorns. The skeletal morphology study conducted on each of the kill assemblages indicates that mortality probably occurred during the spring months, possibly during the seasonal migration between ranges (Miller and Sanders 2000).

Along with the more than 85,000 pieces of heavily butchered bone recovered from the three levels, nearly 90,000 pieces of lithic debitage as well as butchering tools and dart and spear projectile points were also recovered (Miller et al. 1999). In fact, 258 whole and fragmented, notched and stemmed, projectile points provide evidence for the hypothesis "that a brush trap of some sort was used to confine the animals while they were shot" (Miller and Sanders 2000:47).

The site is interpreted as a kill/butchering area associated with an intercept kill of pronghorn on their spring migration, possibly involving the use of a sagebrush corral with V-wings. Although no evidence for one has been found "The horizontally limited nature of the stratum 5 bone bed and the fact that all portions of the pronghorn, from head to toe, were recovered argue for some sort of trap" (Sanders and Miller 2004:167). Pronghorn wounded in open range would scatter and run, so a means of confinement is needed to contain them in an area where they eventually would be butchered as a group.

Even without the trap this site provides evidence of Early Archaic period settlement and subsistence in the upper Green River Basin. It demonstrates the ability of these populations to procure animals other than bison using sophisticated, communal operations. The multi-component nature of the site suggests a long-term use of the area

throughout the Middle Holocene. This site could well represent the earliest evidence for mass hunting of pronghorn in the archaeological record, and holds a uniquely important position in any possible interpretation of pronghorn procurement as the only communal kill older than 1500 B.P. in Wyoming.

3.2.3.17 48SW270 (Small-Scale Procurement)

Similar in time depth and composition to the Oyster Ridge site is 48SW270. This site consists of a large occupation complex on the face of a broad, open, gently undulating slope west of Bitter Creek, a major perennial drainage on the eastern side of the Rock Springs Uplift, in southwest Wyoming (Smith and McNees 2000:75). Sage and rabbitbrush dominate the vegetation at the site; however, the understory includes grasses and forbs. The investigated portion of the site is situated at 2133 m elevation, within a small interdunal basin entirely ringed by a series of sand dunes (Smith and McNees 2000:75). The excavation encompassed a buried stone circle and associated exterior area. Radiocarbon dates for the single component site are 1210 ± 90 B.P. (Beta-38306), 1400 ± 80 B.P. (Beta-41851), and 1460 ± 90 B.P. (Beta-41850) (Smith and McNees 2000:75).

Artifacts and features include the stone circle, 3236 pieces of thermally-altered rock, 60 flaked stone tools, 6483 pieces of lithic debitage, three pieces of groundstone, two bone tools, 12 pieces of bone tube manufacturing debris, and 9098 bone and tooth specimens from three different species (bison, pronghorn, and canid) (Smith and McNees 2000:75). Animal age patterning indicates that at least two, and probably three, bison and at least two pronghorn are represented in the 48SW270 assemblage (Smith and McNees 2000:79). The presence of pronghorn fetal bone is indicative of a late

spring kill whereas the specimens representing another individual indicate a late fall site occupation. This seemingly conflicting site seasonality strongly suggests two separate seasons of site occupation.

The presence of bison (MNI 3) and pronghorn (MNI 2) in the butchering area of 48SW270 indicates that the prehistoric site inhabitants hunted both (Smith and McNees 2000:77). The hunters most likely selected either species depending on what was encountered within the foraging radius from the residential camp. The site inhabitants probably hunted and killed each of these mammals as single individuals (non-communally). The hunting radius for the inhabitants of 48SW270 appears to have been the distance that the entire carcass of these large mammals could economically be transported back to camp. The recovery of most skeletal elements from the excavated portion of the site, including both high and low utility elements, suggests that entire carcasses were carried from the kill location to the camp for butchering (Smith and McNees 2000:80). The fragmented condition of the faunal remains would seem to indicate processing of bone for marrow and grease (Smith and McNees 2000:80). In addition, the possibility of nutritional stress may have been a factor, given the extensive nature of fragmentation.

The inhabitants of 48SW270 probably hunted bison and pronghorn as single animals while the remains of multiple individuals of each species at some sites represents an accumulation of debris from many events. Many residential camps during the Late Prehistoric period appear to be locations of redundant use where hunter-gatherers regularly returned to intensively process animals and other resources. Larger mass kills of either bison or pronghorn occurred only rarely.

3.3 Significant Sites (Canada)

3.3.1 Alberta

3.3.1.1 Blakiston Site (DjPm-115) (Small-Scale Procurement)

The Blakiston site was first identified and recorded in 1985, tested in 1986, 1988, and 1989, and finally excavated in 1990 by Barry Dau of Ethos Consultants Ltd. (Dau 1997:109).This multi-occupation site is located at the confluence of the Oldman and Crowsnest Rivers in southwestern Alberta (Dau 1990, 1997). The site is situated on a low terrace above the rivers and consists of 12 tipi rings, three surface hearths, five stone hearths, and two cairns (Peck 2001:176).

Artifacts recovered from the site include various lithic tools, Late Side-Notched projectile points, and Old Women's pottery (Dau 1990:146; Giering and Peck 1998). In addition, a substantial quantity of worked bone and shell was recovered and subsequently interpreted as ornamental (Dau 1990). A number of artifacts of Euro-Canadian origin were recovered including metal fragments including a possible metal projectile point (Dau 1990).

While highly fragmented bison bone dominated the faunal assemblage, deer, pronghorn (n = 48), elk, beaver and a significant quantity of canid bones were recovered (Dau 1997:127-129, 283). "Given the high percentage of scrap in the faunal sample, it is likely that marrow extraction and grease preparation was a major cultural activity" (Dau 1997:205). Carnivore damage was noted on some of the bone fragments and on a moderate amount of the identifiable bone (Dau 1997:234).

At the Blakiston site 48 pronghorn elements were recovered from 9 separate cultural material units. All of the "species such as elk, antelope and other ungulates are

considered to be food animals" (Dau 1997:185). "The Natives supplemented their diet of bison with other animals from the region" (Dau 1997:290). Small ungulates such as deer and pronghorn were hunted and butchered, although apparently in small numbers (Dau 1997:283). They were found only in those excavation blocks located in the central and southeastern portion of the site (Dau 1997:283). "This pattern may reflect the availability of these animals during the winter" (Dau 1997:283). Perhaps the groups who used the central areas of the Blakiston site were present when deer and pronghorn were accessible and the groups who used the southwestern portion of the site were present when such animals could not be easily hunted (Dau 1997:283). The fact that significant quantities of fetal bison were recovered indicates that bone preservation was good, and differential preservation should have been kept to a minimum.

An examination of the bison tooth eruption and wear as well as the fetal bone indicated that the site had a season of occupation from late fall to late spring (Dau 1990:23); however, it is seen as primarily a winter camp (Dau 1997:117). Additional research utilizing dental cementum analysis was recently undertaken to further refine the season of occupation (Peck 2001). "The best interpretation of these data is that the site represents a late December to late March campsite or series of campsites with habitations possibly lasting into late March and mid June" (Peck 2001:177).

Based on the faunal assemblage, the Blakiston site was interpreted as a campsite where extensive food processing occurred. Radiocarbon dates of 560 ± 230 B.P. (AECV-1121), 730 ± 180 B.P. (AECV-1122), 440 ± 100 B.P. (AECV-1124), 350 ± 100 B.P. (AECV-1126), and 520 ± 90 B.P. (AECV-1130) were generated from charcoal and unburned bone samples (Dau 1997:126). Dau (1990:192) suggested that the artifacts and

radiocarbon dates clearly indicated a fairly continuous occupation by people over a time span of 450 years, starting around 750 B.P. and ending as late as 300 B.P. The artifacts and dates assign the Blakiston site to the Old Women's Phase for the Late Prehistoric components (Peck 2001:177) and possible Protohistoric/Historic occupation (Dau 1997:117).

Although certainly the primary source of food, bison were not the only animals utilized by the native occupants of the Blakiston site. During the course of the winter, they killed small numbers of deer, pronghorn and elk. These animals were probably not actively hunted but taken by chance as they wandered into or passed immediately by the site. Fresh meat from ungulates other than bison must have provided tasty alternatives to what appears to have been a rather bland winter diet (Dau 1997:306).

3.3.1.2 Boss Hill Site (FdPe-4) (Small-Scale Procurement)

As part of the archaeological survey of the Buffalo Lake region of south-central Alberta, Doll (1982) tested the Boss Hill site (FdPe-4) in the summer of 1973. Noting that a side-notched projectile point and several flakes were eroding from a buried soil on top of Boss Hill (designated Locality 1) it was decided that further investigation was warranted. "Later that same summer, excavations revealed a multi-component site with diagnostic artifacts including medium sized side-notched points resembling Besant and Oxbow types" (Doll 1982:7). Faunal remains, from Locality 1, were dominated by bison remains "with the exception of a single pronghorn antelope phalanx" (Doll 1982:7).

The test excavations at Locality 1 recovered projectile points and other evidence of human occupation from strata or a single stratum dating to 2,355 ± 70 B.P. (S-1164), along with an Oxbow-like projectile point from a lower stratum (Doll 1982:8). An

additional radiocarbon date of 1860 ± 55 B.P. (S-1883) was recovered from a bone sample, and confirmed the site chronology (Doll 1982:139).

The significance of the single pronghorn phalanx is that if the animal was procured in the area, as opposed to the transportation or trading-in of the phalanx from regions further to the south, it is an indicator of a drier prairie and semi-arid shortgrass plains environment. While pronghorn has been known to range into the southern section of the Aspen Parkland transition zone (Geist 1988) this occurrence places an individual pronghorn quite far northof the pronghorn's generally accepted prehistoric procurement region (McCabe et al. 2004:21).

3.3.1.3 Bow Island Site (DlOu-72) (Small-Scale Procurement)

The multi-component site, DlOu-72, is located on the South Saskatchewan River, approximately six km northwest of the town of Bow Island, Alberta (Figure 3.1). The site lies at the base of the coulee slope on the east side of the river, atop an alluvial terrace approximately four metres above the high water mark. The terrace is relatively wide, measuring approximately 150 m from the base of the coulee slope to the riverbank (Goldsmith 2003:1-2). Vegetation consists of grasses and brushy species such as wild rose and sagebrush, although excavation has indicated that larger trees existed at the site in the past (Goldsmith 2003:12).

DlOu-72 was discovered during shovel and backhoe testing by Bison Historical Services Ltd. along the proposed Koch Pipelines Canada pipeline right-of-way. During the initial survey this previously unrecorded site produced a significant quantity of unique artifacts. These discoveries prompted the permit holder, A. Sean Goldsmith, to recommend that further investigation, in the form of mitigative excavation, should be

undertaken (Figure 3.4). This was forwarded to the Archaeological Survey of Alberta, with the requested two-stage mitigation format subsequently being approved (Permit 02-110).

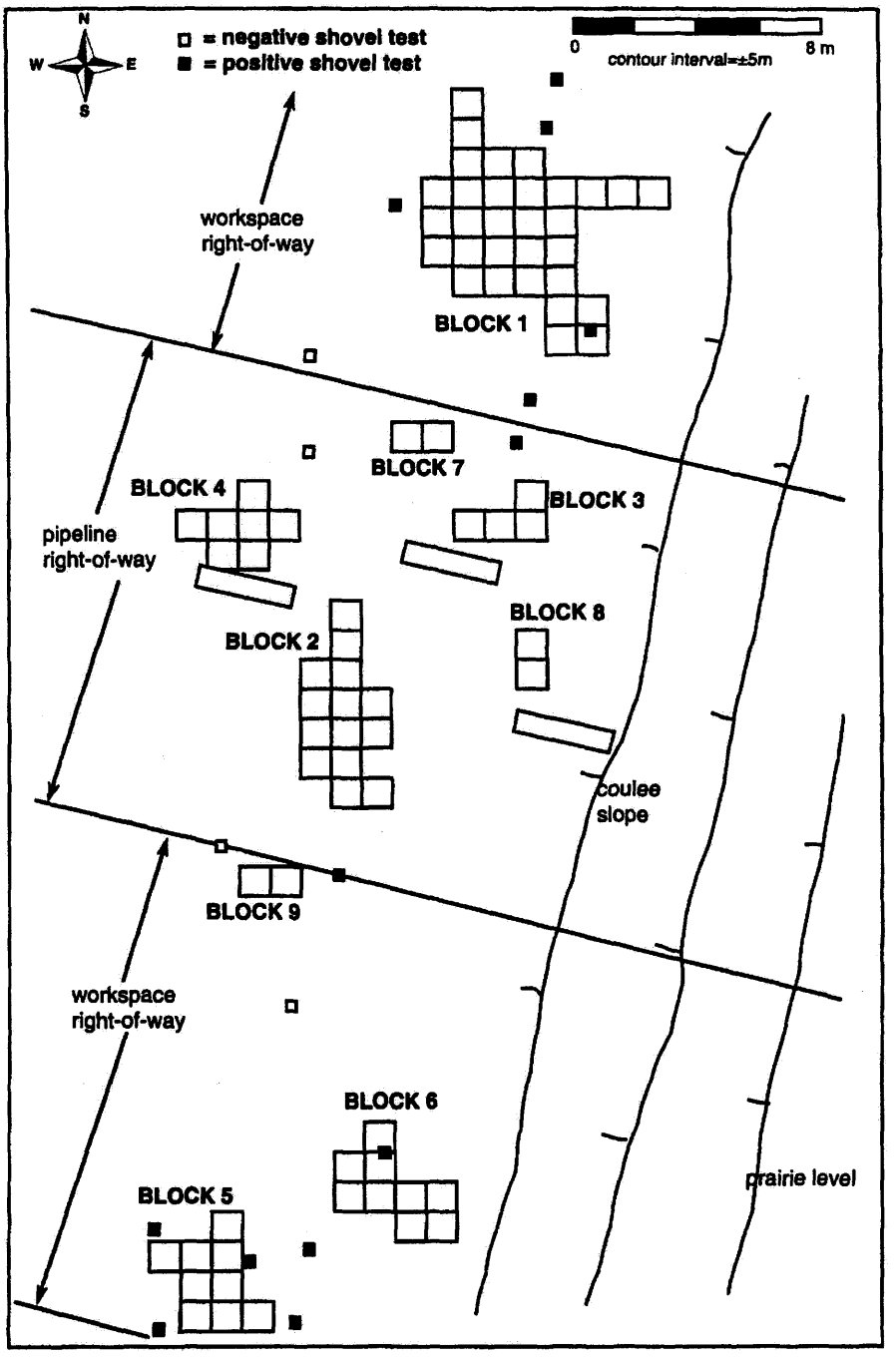


Figure 3.4 Diagram of excavation units, backhoe and shovel tests at DlOu-72 (Goldsmith 2003:60)

A commencement date of June 1st, 2002 was established with the project termination set for July 31st, 2002 (Goldsmith 2003:4). This thesis project focuses on the zooarchaeological material uncovered from DlOu-72 during this period of excavation, with particular attention being paid to the pronghorn remains. These remains have undergone cleaning, conservation, cataloging and initial classification by Bison Historical services staff in their Calgary laboratory facilities.

On behalf of VECO and Koch Pipelines Canada, personnel from Bison Historical Services conducted mitigative excavations at DlOu-72. These excavations were undertaken in two stages. The first stage of the project entailed the removal of 20 square metres from within the right-of-way and temporary workspace. These excavations showed DlOu-72 to be a multi-component subsurface campsite, with discrete cultural layers discernible in a series of preserved paleosols (Goldsmith 2003). Stage two excavations, totaling an additional 60 square metres, further defined the stratigraphic nature of the site, and recovered a significant material assemblage.

The 2002 work at DlOu-72 has proven that the site consisted of five distinct cultural layers, all associated with buried soils and separated from one another by layers of sterile alluvial silt (Figure 3.5). The most recent component has been dated to the Protohistoric period, based on the recovery of glass trade beads and a radiocarbon date of 170 ± 50 B.P. (Beta-175618) (Goldsmith 2003:122,162). While the third and fifth components have been dated, based on recovered projectile points, and a radiocarbon date of 180 ± 50 B.P. (Beta-175619), to the Late Precontact and Protohistoric period (Goldsmith 2003:122,163).

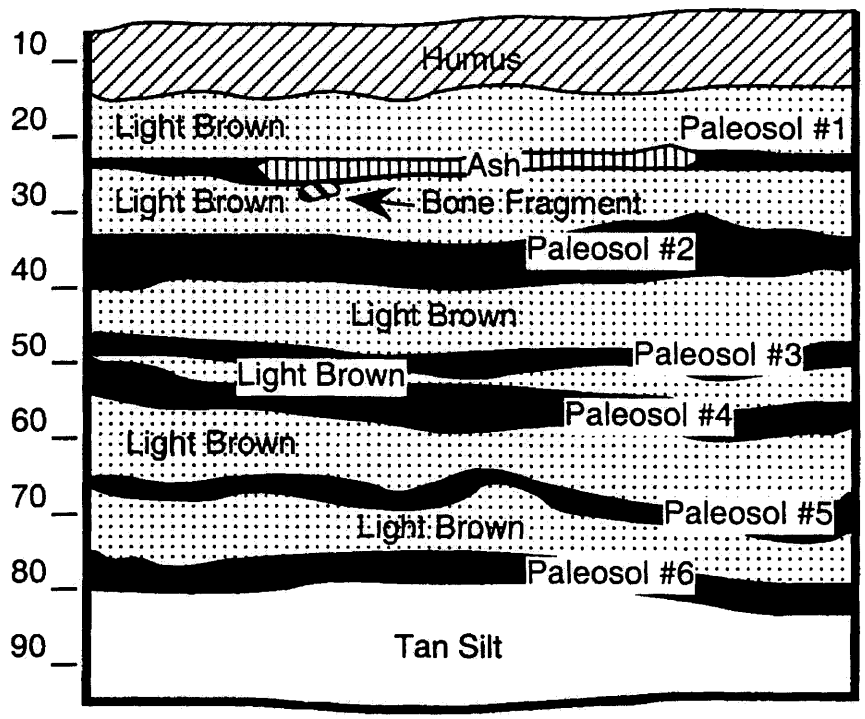


Figure 3.5 Typical sediment profile from west wall, unit 53N 12W, DlOu-72 (Goldsmith 2003:65)

The five cultural components at DlOu-72 associate very clearly with five of the six numbered paleosols (Goldsmith 2003:66). Paleosol 4 was associated with so little cultural material that it is not considered to represent an occupation (Goldsmith 2003:68). Thus, Component 1 materials are associated with the humus layer and Paleosol 1, Component 2 with Paleosol 2, Component 3 with Paleosol 3, Component 4 with Paleosol 5, Component 5 with Paleosol 6 (Goldsmith 2003:66). To avoid the confusion that might arise if the descriptions in this thesis continued to switch between references to paleosols versus cultural layer, therefore, the following discussions will refer exclusively to Components 1 through 5.

The cultural assemblage for all five components is dominated by bone, with limited quantities of lithic tools and debitage, thermally-altered rock, and a small sample of ceramic sherds. Considered as a whole, the site exhibits excellent stratigraphic integrity

and the highly patterned spatial distribution of material suggests the intact preservation of ancient activity areas (Goldsmith 2003). With regard to the pronghorn faunal assemblages from the various components, only Components 1 and 2 contained material that is relevant to this thesis.

DlOu-72 presents us with a rare glimpse of the dramatic, although poorly understood, cultural and material transition that accompanied the European arrival in what is now southern Alberta. For example, although all five cultural components seem to be closely related temporally, preliminary artifact analysis shows a significant variation in their respective faunal assemblages. The assemblage trends from complete bison utilization in the oldest component towards pronghorn in the upper layers. Further analysis of this faunal material should help to illuminate the significance of this pattern and provide additional zooarchaeological information with regard to this important time period.

3.3.1.4 Cactus Flower Site (EbOp-16) (Small-Scale Procurement)

The Cactus Flower site, located on the South Saskatchewan River north of Medicine Hat, is one of the most extensively excavated McKean campsites on the southeastern Alberta Plains (Brumley 1975, 1978). About 180 square metres of this multi-component site's surface were excavated (Brumley 1975:7-9). Ten occupations were defined: the upper two components were assigned to the Pelican Lake Phase, while the remaining eight were assigned to the McKean Phase (Brumley 1975:15). Radiocarbon dates range from 4220 ± 130 B. P. (S-1210) to 2130 ± 130 B. P. (S-783), and include 3,620 ± 95 B.P. (S-822), 3705 ± 80 B. P. (S-784), 3970 ± 160 B. P. (S-820), 4,130 ± 85 B.P. (S-

782) (Brumley 1975:13). All of the dates indicate occupations during the Middle to Late Middle Prehistoric period (Brumley 1975:3-4).

Features excavated include 49 surface and basin hearths, ash concentrations, and earth pits, in addition to numerous articulated and associated bone units (Brumley 1975:19-37). Artifacts recovered included projectile points and lithic tools, pecked and ground stone tools, fossils, bone tools, shell artifacts, as well as faunal remains (Brumley 1975:38-75). Interpretation of these features and the associated artifacts indicates that the site was utilized as a habitation locality spanning over one thousand years (Brumley 1975; Vickers 1986:69)

Age estimates on bison mandibles suggest an October/November occupation, whereas fetal and calf elements indicate a spring occupation (Vickers 1986:71). Brumley (1975:79, 1978:181) believes that the Cactus Flower site was occupied from early spring to late fall.

The faunal remains from all levels are dominated by bison, with pronghorn, mule deer, canid, kit fox, rabbit, birds, freshwater clam and fish also occurring; the latter five fauna are minimally represented (Brumley 1975:78-82; Vickers 1986:71). Included in the site's faunal assemblage are 898 bison elements representing no less than 40 individuals, and 56 elements from six pronghorn (Brumley 1975:78-79). This would seem to indicate that pronghorn represented a secondary, but minor food source in relation to bison. The skull was the most common pronghorn element (n = 4) and second most common bison element. The skull was thoroughly processed in order to obtain the brains and nasal cartilage (Brumley 1975:85, 1978:189).

The overall impression which Brumley (1975:91) noted "in examining the butchered bison and antelope remains was that the patterns of bone breakage were, for the most part, of the sort resulting from the processing of elements for the extraction of marrow and grease". In addition, Brumley (1975:93, 1978:192) inferred from faunal remains that the pronghorn were killed and largely butchered some distance away before being transported to camp. Only single or small groups of pronghorn were being procured by means of individual or small group hunting techniques, and based on the average number of bison to pronghorn elements the pronghorn were being taken in fortuitous hunting episodes or in times of need.

Differences in element frequency per minimum number of individuals for pronghorn in comparison to bison was used as evidence to suggest the two species were being hunted using different methods and in differing locales. Brumley (1975:83) examined the faunal remains in terms of the "schlepp effect" (Daly 1969:149), noting that there were twice as many elements in the campsite per individual bison as there are for individual pronghorn. It was inferred, from these data, that the pronghorn remains came from a kill/butchering site located some distance away from the campsite suggesting transportation of butchered units to the camp (Brumley 1975:93).

Referring to the ethnographic link between Historic and Prehistoric hunters, Brumley (1975:93) states that "Accounts of how various historic plains groups hunted antelope may closely parallel the method utilized by McKean hunters at this site. The Indian hunter would creep up behind the crest of a small hill beyond which the antelope could be seen grazing. He would then raise and begin to wave a flag made of a stick with a piece of hide or cloth tied to it so that the antelope would see it. Pronghorn are extremely

curious animals and, seeing no apparent danger, slowly approach to investigate. The hunter would remain concealed waving his flag until one of the animals was close enough to be killed" (Brumley 1975:93, 1978:192). Archaeologically the pronghorn remains provide evidence of the utilization of this species by Middle and Late Middle Prehistoric period cultural groups.

Brumley (1975:91) considers the repeated McKean occupation of the Cactus Flower site to be a function of local topography and bison hunting techniques. The valley of the South Saskatchewan River in the area is very deep; sheer cliffs of up to 90 m prevent access along much of its length. Near the site location, however, slopes provide easy access to the river. It is argued that McKean hunters chose the location in order to ambush bison attempting to water or ford at this spot. The steady decline in site use after the McKean occupations is thought to reflect a shift in hunting techniques, perhaps to ones employing jumps and pounds (Vickers 1986:71).

3.3.1.5 EdPc-10 (Small-Scale Procurement)

The excavation of EdPc-10 was undertaken in 1980 by Lifeways of Canada, as part of a historical resource impact assessment of the 240 kV Alberta Powerline to Brooks, Brooks to 924 L powerline system west of Brooks, Alberta (Head 1980). EdPc-10 was a buried site situated on the first terrace above the existing floodplain on the east side of the Bow River (Head 1980:5). Based on cultural material "exposed in the extensive erosional cuts in the area" (Head 1980:5), an initial 2x2 m excavation was undertaken which located part of a stone arc. Subsequently the remainder of the stones (n = 87) were excavated, along with areas adjacent to them (Head 1980:21). This confirmed that the site consisted of a Late Prehistoric or Early Historic tipi ring of some significance (Head

1980:5). The possible historic association was based on a square nail and 2 metal disc fragments (Head 1980:23). These metal objects were found in association with 31 lithic artifacts, including a straight-based Late Plains projectile point and 2 point fragments, bone, bivalve and fossil ammonite fragments, and assorted thermally-altered rock (Head 1980).

The faunal assemblage is composed largely of fragmentary remains (n = 669), resulting from poor preservation and deliberate human bone breaking (Driver 1980:1); however, analysis resulted in the identification of 4 species including bison, pronghorn, canid and fish (Head 1980:23). Three elements, a proximal ulna and 2 metatarsal midshaft fragments, were found at EdPc-10 and identified as pronghorn (Head 1980:Appendix 1:16). "The identification of midshaft metatarsus as antelope rather than deer to which they are quite similar was based upon their more slender dimensions" (Head 1980:Appendix 1:16).

Seasonality of the site occupation was determined as spring to early fall, based on indirect evidence from fetal bison bone, and the presence of burbot (*Lota lota*) (Driver 1980:4-6; Head 1980:24). "The recovered artifactual and faunal remains and their distributions suggest the site represented a short-term summer encampment in which bison and antelope carcasses, which had been killed elsewhere, were stripped of the meat at the kill or butchered and prepared outside the tipi" (Head 1980:25). Bone fragments present suggested discard of fragmentary bones after meat stripping and consumption. The artifacts recovered suggested little in the way of domestic activities, instead suggesting perhaps that arrows had been retipped in the tipi (Head 1980).

However, the lack of recovered lithic debitage from projectile point manufacture, provides little evidence in this regard.

EdPc-10 was a unique stone circle in terms of faunal material recovered. In fact, its excavation added to the understanding of resource use, specifically faunal utilization during the historic period (1750-1850 A.D.) (Head 1980:22). "While bison and dog are fairly common occurrences in other excavated ring sites in Alberta, this is the first time that either antelope or fish have been identified" (Head 1980:25).

3.3.1.6 Empress Tipi Ring Site (EfOo-130) (Small-Scale Procurement)

Blood residue analysis was conducted on a number of artifacts from the Empress Tipi Ring site (EfOo-130). Of particular interest to this research is artifact number 7207, an Avonlea phase projectile point that tested positive for deer, pronghorn, and rabbit blood (Golder Associates Ltd. 2000:129) (Table 3.1). The faunal remains recovered at the Empress Tipi Ring Site were largely fragmentary with only a few confident species level identifications being made (Golder Associates Ltd. 2000). Bison, canid, pronghorn and possibly rabbit were identified during excavations, however, deer was not found in an identifiable state (Golder Associates Ltd. 2000:129).

Given the quantity of bison remains recovered the absence of bison blood on any of the lithic artifacts submitted is surprising. "[As] the site shows a considerable amount of bison processing, it would [also] seem unusual for two arrow points to retain rabbit blood" (Golder Associates Ltd. 2000:130). It is possible that the rabbit was either part of the prehistoric diet, or that rabbit sinew was used as a binding material for hafting the projectile points (Golder Associates Ltd. 2000).

The presence of blood relating to the pronghorn and deer families on one of the Avonlea points could be reasonably anticipated. In fact, pronghorn and deer are currently prevalent in the site area and could have been available for procurement prehistorically as well (Golder Associates Ltd. 2000:130.

Artifact Number	Artifact Type	Result
4950	Retouched flake	-
7126	End scraper	-
7207	Avonlea Phase point	Pronghorn, Deer, Rabbit
7810	Avonlea Phase point	-
8101	Old Women's Phase point	-
9738	End scraper	Canid
13456	Plains Triangular point	-
12266	Old Women's Phase point	Rabbit

Table 3.1 Results of immunological analysis of artifacts from the Empress Tipi Ring Site (Golder Associates 2000).

3.3.1.7 Forty Mile Coulee (DjOu-62) (Small-Scale Procurement)

Historical resource work was carried out within the Forty Mile Coulee area of southeastern Alberta in order to mitigate the effects of construction of an approximately 10 km long irrigation reservoir (Brumley and Dau 1988; Dau and Brumley 1987). Archaeological investigations conducted between 1981 and 1986 resulted in the discovery of 108 sites, containing 471 identified features (Brumley and Dau 1988:206).

One of the mitigated sites was DjOu-62, which is located at the bottom of Forty Mile Coulee and consists of 14 stone circles situated in a grassland environment with close access to seasonally available water (Brumley and Peck 2000:82). Six of the 14 stone circles were tested, which resulted in the recovery of Late Plains/Prairie side-notched (Cayley Series) projectile points (Brumley and Dau 1988:243). In addition, a metal fragment and a Saskatchewan Basin Complex potsherd were also recovered (Brumley and Dau 1988:243), indicating a possible Protohistoric age for the site. Bison bones were

recovered which yielded radiocarbon dates of 250 ± 80 B.P. (Beta-6716), 230 ± 90 B.P. (Beta-19801) and 470 ± 70 B.P. (Beta-19802) (Brumley and Dau 1988:243).

The site was interpreted as a series of occupations that date to the Late Prehistoric and Protohistoric periods (Brumley and Dau 1988:243-244; Brumley and Peck 2000:82). "The recovery of Plains/Prairie side-notched projectile points, pottery likely attributable to the Saskatchewan Basin Complex, the [radiocarbon] dates, and the recovery of historic items in association suggest this is an Old Women's phase site" (Peck 2001:179)

Bison remains constitute the bulk of the identifiable faunal sample, consisting of 691 elements which represent a minimum of 103 animals (Brumley and Dau 1988:151). With one exception, the remains of one or two bison were recovered from each of the sites/features. The exception is DjOu-62, where a minimum of nine animals are represented at Stone Circle 12; and three animals each are represented at Stone Circles 11 and 14 (Brumley and Dau 1988:151). Based on the bison dentition, Peck (2001) has suggested late March to late October as the season of site occupation.

Analysis Unit 5 had the largest concentration of identifiable pronghorn elements (n = 3); they included a left astragalus, calcaneum, and metatarsal.

Brumley and Dau (1988:151) indicated that "Although mule deer are presently abundant within the coulee area, antelope is the only other ungulate species represented in the Forty Mile Coulee sample." This statement is supported by: "A total of 16 antelope elements [being] identified representing a minimum of 10 individuals from 10 different site/feature locations" (Dau and Brumley 1987:902). In addition to DjOu-62, DjOu –5, 23, 49, 60, and 71 all produced small quantities of pronghorn remains. See Table 3.2

below for a summary of the pronghorn remains recovered from the Forty Mile Coulee sites.

Site No.	Analysis Unit	Element	Side
DjOu-5	1	Pelvis	Unidentified
		P-1	Left
		P-1	Right
DjOu-23	1	Metacarpal	Right
DjOu-49	1	Humerus	Unidentified
		Tibia	Left
DjOu-49	2	Lumbar Vert.	Axial
		Pelvis	Left
DjOu-60	12	Calcaneum	Left
DjOu-60	16	Tibia	Right
DjOu-60	22	Metapodial Frags.	Unidentified
DjOu-60	23	Tibia	Right
DjOu-62	5	Astragalus	Left
		Calcaneum	Left
		Metatarsal	Left
DjOu-71	1	P-1	Unidentified

Table 3.2 Forty Mile Coulee pronghorn assemblage data summary (Table compiled from Brumley and Dau 1988)

3.3.1.8 Laidlaw Antelope Trap (DlOu-9) (Communal Procurement)

The only archaeological evidence, known to this author, for the communal hunting of pronghorn on the northern Plains is the Laidlaw site situated in southeastern Alberta near the city of Medicine Hat. The site is located on a level terrace surface, approximately 2.5 km long by 1 km wide, midway up the north face of the South Saskatchewan River valley, approximately 1.5 km north of the present river channel (Brumley 1983:1-4).

This site consists of four spatially associated features, the most prominent of which is a pronghorn pit trap (Figure 3.6). The layout of this features "strongly suggests its function as a trap or pound structure, with recovered faunal remains indicating antelope were the animals being hunted" (Brumley 1983:21)

The main component of this procurement complex consists of an excavated earth pit with a stone wall constructed around its margin (Brumley 1983:4-8). Upon excavation of the interior of the enclosure in 1983, a number of stones were found, leading the excavators to reason that the walls had collapsed inward sometime after abandonment, filling the interior of the pit (Brumley 1986:205). "The enclosed area is wider at its westernmost end, there having an inside width of 3.75 metres. The opposite end has an inside width of 2.5 metres. The inside length of the structure is 7.1 metres and it has a total inside area of 22.2 square metres" (Brumley 1983:8). "The floor of this pit was apparently excavated to at least 80 cm below original ground surface and sloped downwards towards its northeast end" (Brumley 1983:9). The amount of stone removed from within the pit suggests that the walls, as originally constructed, were probably from 80 to 100 cm high (Brumley 1984:102). "The trap structure is quite small and it is impossible to imagine more than 20 or 30 antelope in it at any one time" (Brumley 1983:42).

In addition, "two relatively straight stone lines converge and terminate on adjacent corners of a roughly rectangular stone enclosure" (Brumley 1984:98). These stone alignments extend for a distance of 29-35 m and have been interpreted as stone walls forming the drive lane part of the pronghorn trapping complex (Brumley 1983:4-8).

At the Laidlaw site pronghorn hunters took advantage of the natural topography in driving the animals between the two converging fences and into the small catch pen/pit (Frison 1987, 1991a). The trap is situated, apparently deliberately, at the downwind end of a natural trough-like feature formed by two, essentially parallel stony ridges. "Towards their south ends, the two stony crests of these ridges probably served as natural unmodified drive lanes, with hunters stationed along them at intervals in order to keep the antelope moving toward the kill at a high speed" (Brumley 1983:42). Pronghorn would have been hazed by aboriginal hunters into the south end of this natural chute and then stampeded toward the pit (Brumley 1983:42). Presumably most of these animals were stunned or injured as a result of their abrupt entry into the trap and were easily dispatched with clubs (Brumley 1984:124).

Situated a short distance away are a circular stone walled enclosure and two stone rings (Figure 3.6). Partial excavation of the features indicates the two stone rings to be tipi rings. "One of these stone circles has an unusually large inside diameter" (Brumley 1986:205). The stone walled enclosure is thought to represent "a structure used in conducting shamanistic rituals during the course of the hunt, which were intended to insure success" (Brumley 1984:125). In the case of this pronghorn trap, stone was used for building material instead of wood due to the fact that the nearest source of timber was several kilometres away and fieldstones would have been very abundant (Brumley 1983:41).

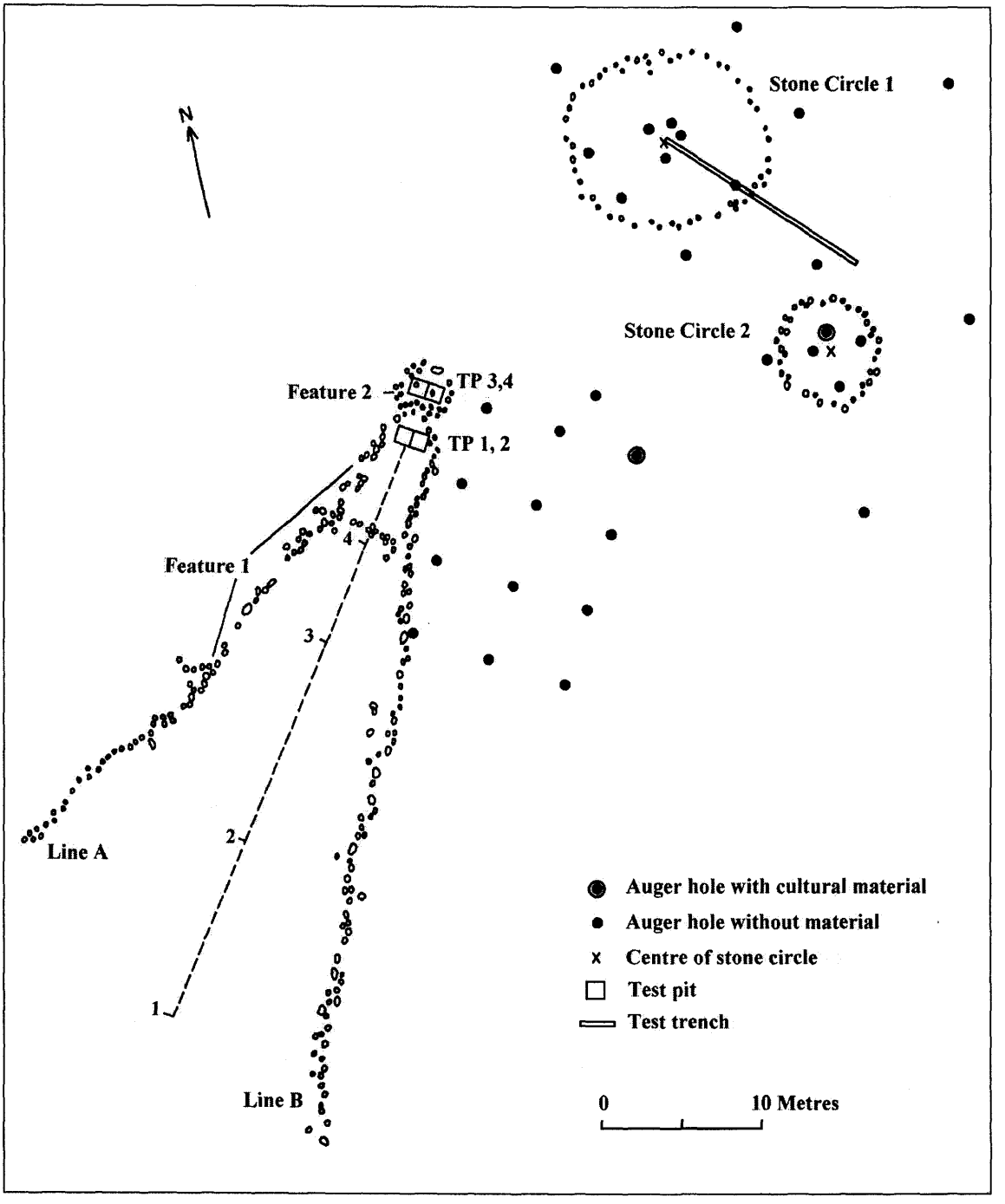


Figure 3.6 Laidlaw site cultural features (Brumley 1983:100)

Test excavations in the silted-in pit and adjacent features conducted by Brumley in 1983 yielded a very limited quantity of associated cultural material (Brumley 1984). The artifacts that were recovered included numerous fragmented pieces of pronghorn (n =

21), and bison-sized bone (n = 2) from the excavated pit within the rectangular enclosure, and a few non-diagnostic lithic artifacts (n = 5) (Brumley: 1983, 1984). "All bone fragments were less than 4 cm in maximum length" (Brumley 1984:160). The scarcity of the faunal remains was interpreted as indicating that the pronghorn were not butchered in the pit but carried to some other location for processing. As an Alberta male pronghorn's average weight is 58 kg this would be a fairly straight forward task for the people involved (Brumley 1984).

With the exception of the areas beneath and around the stones sampled by Test Pits 1 to 4, the Laidlaw site surface does not provide a good environment for preservation of faunal remains (Brumley 1984:106). "The minimal amount of faunal material recovered in augering in the area adjacent to the south side of [the pit feature] may reflect poor bone preservation factors and/or that butchering and processing activities were conducted elsewhere" (Brumley 1983:43).

A date of 3280 ± 110 B.P. (Beta-11952), with a normalized date of 3420 ± 130 B.P. was obtained from pronghorn bone (Brumley 1986:205). This date places the Laidlaw site into the Early Middle Prehistoric Period (Brumley 1986:205). "An examination of similarly dated archaeological materials in Alberta indicates that the trap could be associated with the terminus of the McKean or Oxbow Phases, or with the initial Pelican Lake Phase" (Brumley 1986:205-206).

The Laidlaw site reflects one of a variety of pronghorn procurement strategies documented historically for aboriginal groups on the northern Plains (Brumley 1983:46, 1984:126). However, it must also be remembered that the Laidlaw Antelope Trap is an

anomaly on the northern Plains and therefore cannot be considered the primary strategy for the prehistoric procurement of pronghorn.

3.3.1.9 Larson Site (DlOn-3) (Small-Scale Procurement)

The Larson site is located approximately 3 km south of the village of Irvine and 30 km east of Medicine Hat, Alberta (Milne 1987:215, 1988:43). Discovered in 1975 it was not until 1982 and 1986 that excavations were conducted within the site area. Three cultural levels were recorded; the uppermost level represents an Old Womens's phase campsite, based on radiocarbon dates and projectile points. The second level represents a series of closely spaced Avonlea Phase occupations, with associated features. The third level consists of a disarticulated bone bed, which lacks diagnostic artifacts and was most likely redeposited from elsewhere (Milne 1987:215).

For the purpose of this research it is the Avonlea Phase occupation levels (Level 2) that are of most interest due to the presence of pronghorn remains. The dating of these levels is based on diagnostic artifacts and five radiocarbon dates obtained from charcoal and bone samples. The recovered dates are 2480 ± 150 B.P. (GX-9395-A), 1165 ± 125 B.P. (GX-9396-G), 1190 ± 80 B.P. (AECV-298C), 1210 ± 80 B.P. (AECV-299C), and 1140 ± 90 B.P. (AECV-300C) (Milne 1987:216, 1988:49).

The features uncovered include numerous prepared and unprepared hearths, stone boiling pits and roasting pits (Milne 1987:216). Extensive quantities of ash, thermally-altered rock, and heavily butchered bone are also present. The various features within the Avonlea Phase occupations are thought to represent campsite activity areas.

The artifact assemblage consists of lithic debitage, bone and lithic tools including small, thin, finely worked Avonlea side-notched projectile points (n = 22), ceramics and

quantities of butchered and processed bone (Milne 1987:216). The amounts, distributions and kinds of cultural material are indicative of a camp location selected for proximity to game, lithic material, wood, water and shelter (Milne 1988:63).

Analysis of the faunal assemblage showed "that bison, pronghorn, dog, swift fox, mink (?) and duck are represented, with bison being prevalent" (Milne 1987:216). "Bison remains represented a minimum of five adult or subadult individuals and the remains of one foetal calf" (Milne 1988:54). Based on seasonality suggested by foetal bison the site was a late winter (mid-February) occupation (Milne 1988:55). In addition, "the duck provides weak evidence of spring through fall occupation (Milne 1987:216, 1988:56). "Pronghorn antelope was identified on the basis of a single complete left navicular cuboid. A second piece representing a part of an internal auditory meatus from a small ungulate is probably also antelope" (Milne 1988:56). The minimum number of individuals present is 1 adult pronghorn (Milne 1988:54). "The pronghorn antelope presumably was primarily obtained for meat (Milne 1988:56).

Cultural features encountered in the site area indicate a heavy emphasis on food processing, specifically for grease and marrow. This is reflected in the faunal assemblage by the extensive fragmentation of the faunal remains. Unfortunately, extensive weathering and modification of much of the sample by carnivores has limited the extent to which this material can be interpreted (Milne 1988:56).

In spite of the presence of several animal species at the Larson site, bison was clearly the only species providing significant quantities of meat for food. This is reflects the site's proximity to, and apparent association with, the Irvine Bison Kill, DlOn-2 (Milne 1988:56). Avonlea site data suggest a procurement strategy where bison dominated the

subsistence system with minor use of other locally available smaller species (Milne 1988:64).

3.3.1.10 Little Bow Reservoir Site (EbPi-75) (Small-Scale Procurement)

The multi-occupation site of EbPi-75 was mitigated during the Little Bow Reservoir Project, Mosquito Creek Segment, and is situated within the valley created by Mosquito Creek. Located near the village of Champion, in southern Alberta, the site lies on a low terrace, between two isolated erosional outliers, on the northwest side of Mosquito Creek (Head et al. 1989:145). It is well sheltered, in a somewhat "hidden" location, particularly from the north, yet provides a good view downstream towards the confluence with the Little Bow River (Landals and Tischer 2001:206) (Figure 3.7). The southeasterly aspect would have provided access to the early morning sun, particularly in winter. Although the terrace has never been cultivated, some historic and recent ranching activities have caused localized disturbances. Based on the current vegetation, the site was heavily grazed in the past (Landals and Tischer 2001:210).

Two river drainages will be impacted by the development of the Little Bow Reservoir: the Little Bow River and Mosquito Creek (Landals and Webster 2002:1). All of the Little Bow Reservoir site features discussed in this thesis are situated on the Mosquito Creek drainage, below the full-supply line of the proposed reservoir. This portion of the project is referred to as the Mosquito Creek segment.

EbPi-75 was recorded during the Historical Resources Impact Assessment for the Little Bow Reservoir Project (Head et al. 1989:145). It was shovel and backhoe tested by Bison Historical Services Ltd., and documented as consisting of at least 12 archaeological features, many of which exhibited little or no burial. This was taken to

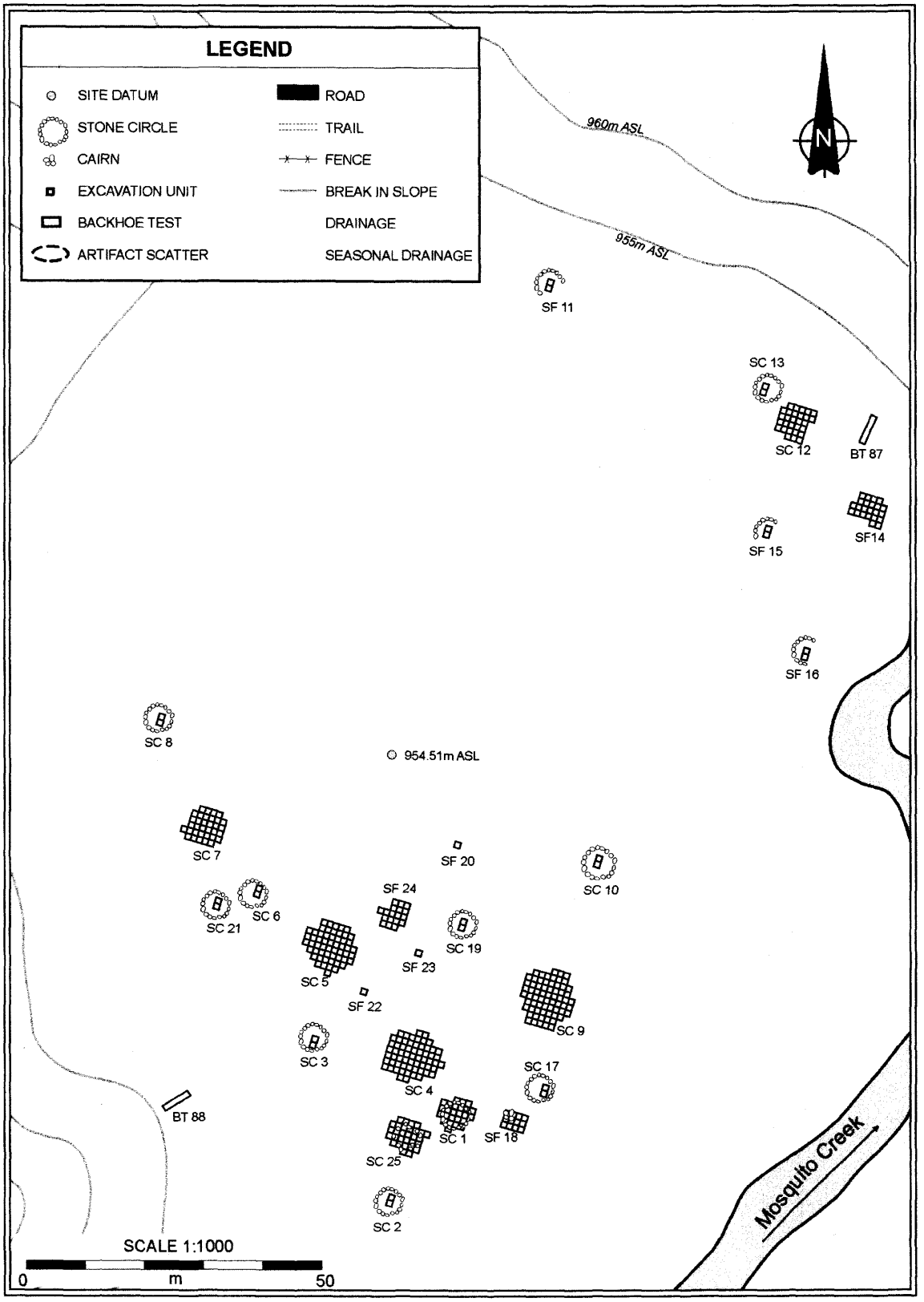


Figure 3.7 EbPi-75 cultural and topographical features (adapted from Landals and Tischer 2001:207).

indicate a relatively recent period of site use (Head et al. 1989:145; Landals and Tischer 2001:206). During the initial survey this site produced a limited quantity of artifacts, comprised mostly of small bone fragments. "Most of the cultural material at the site appeared to be within the upper 10 cm of the profile" (Landals and Tischer 2001:206). These discoveries prompted the Archaeological Survey of Alberta to acknowledge that further investigation (Stage 1 mitigation), in the form of 24 square meters of excavation units, should be undertaken. The excavation units were to be used to assess the interior of each of the 12 stone circles, under Permit 2000-082 (Landals and Tischer 2001).

During the 2000 field program, 9 of the original 12 archaeological features were re-identified and documented and an additional 13 new features were discovered. These new features included both stone circles and cairns, bringing the site total to 25 archaeological features (Landals and Tischer 2001:210). Completion of the 2000 mitigation program provided evidence that the site was of high potential significance, and additional excavations were warranted.

As radiocarbon dates are unavailable at this time, dating of EbPi-75 is based on the recovery of offset awls, which are commonly found on historic sites dating between 1740 CE and 1830 CE (Landals, personal communication 2005). The principal investigator concludes that this is an accurate date for EbPi-75, and has therefore, placed the occupation of the site into the Protohistoric/Historic period. With regard to additional dating of the southern cluster of features, "the presence of a distinct, flood deposited tan silt, in combination with the thin ubiquitous hearths, permits microstratigraphic separation of at least two Protohistoric occupations in this area of the site" (Landals and Tischer 2001:275). The results of the dental cementum analysis on samples #468 and

#3642 indicated that they both were from a spring kill episode. This is interpreted as falling between the end of March and mid-June (Landals, personal communication 2005).

3.3.1.11 Saamis Site (EaOp-6) (Small-Scale Procurement)

The Saamis site is a Late Prehistoric and Protohistoric period campsite located within the city limits of Medicine Hat, in southeastern Alberta. This very extensive camp and butchering site is located on two stream terraces of Seven Persons Creek, at an elevation of 671 m (Milne-Brumley 1978:7). "A total of 79 features were recorded, including individual living floors, bone piles, rock piles, prepared and unprepared hearths and bone caches" (Milne-Brumley 1978:16). Typological cross-dating provided by the ceramics and projectile points, the presence of historic trade goods and three radiocarbon dates, 435 ± 125 B. P. (S-824), 85 ± 70 B. P. (S-825), 210 ± 80 B. P. (S-827) indicates a terminal Late Prehistoric and Protohistoric occupancy for EaOp-6 (Milne-Brumley 1978:33-35). Based on fetal bison bone the season of occupation of the Saamis site appears to be late winter or early spring, (Milne-Brumley 1978:130-131)

Cultural material recovered from the 975 square metres of exposed living floor included lithic and metal projectile points and tools, glass and stone beads, pecked, ground and abraded stone artifacts, worked bone artifacts, shell artifacts, precontact ceramics, thermally-altered rock and faunal remains (Milne-Brumley 1978).

The occupants of the site utilized a variety of animal resources. The faunal assemblage includes bison, black bear, wolf, red fox, golden eagle, white-tailed deer, pronghorn, snowshoe hare and Richardson's ground squirrel (Milne-Brumley 1978); however: "The bison comprise well over 95 % of the faunal assemblage" (Milne-

Brumley 1978:127). These animals represent the principal food source for the site occupants and due to the quantity of remains recovered they were probably taken during a communal hunt (Milne-Brumley 1978:127).

Excavators recovered the remains of a minimum of three pronghorn individuals. "The skeletal elements include a mandible, scapula, ulna, radius, humerus, metacarpal, scaphoid, magnum, lunate, innominate, tibia, metatarsal, astragalus, calcaneum, navicular-cuboid and phalanges" (Milne-Brumley 1978:128). Since most body elements were found, it is likely that the animals were killed elsewhere and carried back to camp for processing and consumption (Milne-Brumley 1978:129). The "small ungulates such as antelope or deer may have been captured by snaring or stalking" (Milne-Brumley 1978:133).

An attempt to reconstruct the culture represented resulted in the conclusion that the Saamis site was an aggregation of people who had come together in order to carry out a spring bison hunt (Milne-Brumley 1978:140). The excavation of this site affirms the pattern of resource exploitation which archaeologists have postulated for the aboriginal peoples of the early Historic period on the northern Plains.

3.3.1.12 St. Mary Reservoir (DhPg-8) (Unclassified)

Located in southern Alberta, approximately 16 km northeast of the town of Cardston, this site is situated on the bed of the St. Mary River reservoir and is underwater except for periods of draw down which expose the site (Tolman 2001). Wind deflation and wave erosion of the unprotected sediments have exposed a variety of lithic artifacts (n = 5677) indicating a human presence, at least intermittently, from 11,350 ± 80 B.P. (TO-7972) into the historic period (Tolman 2001:63).

Faunal remains recovered from the site include extinct horse *(Equus conversidens)*, extinct bison (*Bison antiquus*), extinct helmeted muskox (*Bootherium bombifrons*), bison (*Bison bison*), caribou (*Rangifer tarrandus*) as well as a number of other small mammal species (Tolman 2001:1-2). However, no pronghorn remains have been collected from DhPg-8, to date.

Of relevance to this research are two lithic eccentrics "with no affiliates known on the Great Plains" (Tolman 2001:110). Surface collected in 1997 from within a 2m radius, were nine Knife River Flint lithic fragments. The pieces were subsequently reassembled to form one complete and another partially complete "strikingly similar" eccentric artifacts (H99.22-1000 and H99.22-1001) (Tolman 2001:110) (Figure 3.8).

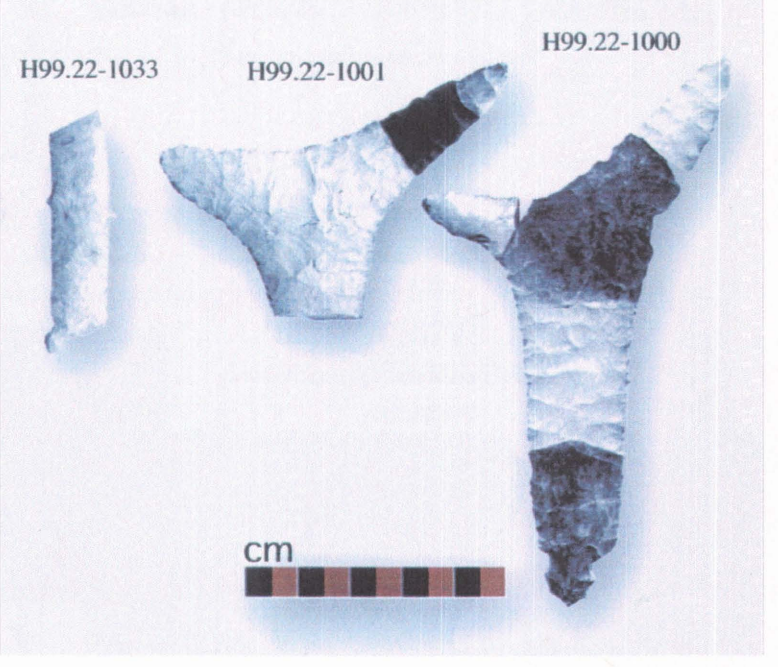


Figure 3.8 DhPg-8 Lithic Eccentrics
(Tolman 2001:212)

The fragmented artifacts exhibit varying degrees of patination, and when refit "are two pronged distally with a relatively short medial prong and larger distal prong"

(Tolman 2001:111). An interpretation, based on metric measurments, by Tolman (2001:117-123) suggests that the eccentrics resemble *Antilocapra americana* horns.

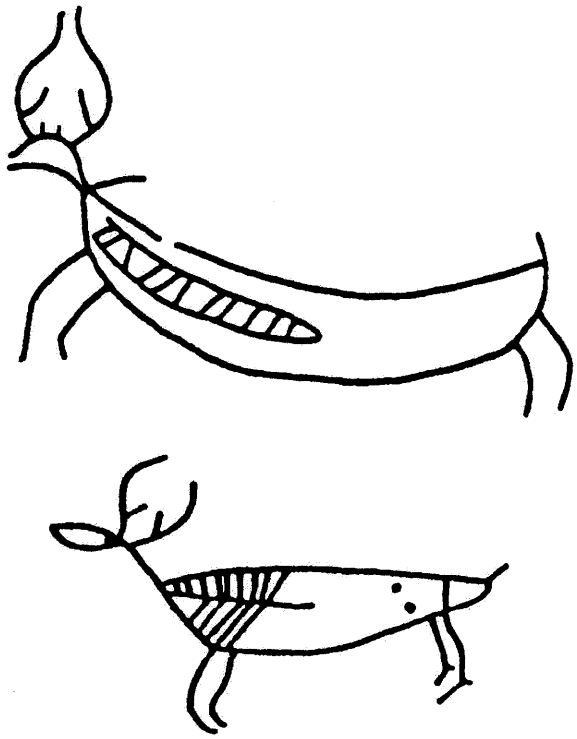
Absolute dating of the artifacts is not possible, however, Tolman (2001:137) has assigned the eccentrics "to the Early Prehistoric Period at least as old as the Cody complex and possibly affiliated with the Clovis complex". This was based on a relative dating technique involving the degree of patination, the flaking technology employed (using hard hammer percussion) and the overall large size (Tolman 2001:175).

Tolman (2001:146) postulates that these "Pronghorn eccentrics may well be a pair of very sacred iconic emblems that elevated the bearer above the common to a spiritual status relative to the importance of these lifeways strategies associated with mass large mammal procurement". In addition Tolman (2001:146) states that "Given conclusions based on the patination sequence, the [DhPg-8] specimens may well be among the earliest known ornamental manifestations of these [communal] impoundment practices and/or related ceremonies occurring during the Paleoindian Period." Tolman (2001:147) also observes that "if, indeed, they are ornamental manifestations representing *Antilocapra americana*, considerations for *Antilocapra americana* procurement [within the southern Alberta region] need to be investigated".

3.3.1.13 Writing-On-Stone Provincial Park (Unclassified)

A petroglyph depicting "a boat-shaped antelope leap[ing] towards a pointed shoulder figure" is present at Writing-On-Stone Provincial Park, in southern Alberta (Archaeological Society of Alberta 1995:23), along with several other depictions of pronghorn (McCabe et al. 2004:88) (Figure 3.9). These zoomorphs are etched into the sandstone rock faces overlooking the Milk River. Their presence in southeastern Alberta

lends support, albeit tentatively, to the hypothesis of small-scale procurement of pronghorn on the northern Plains.



Figures 3.9 Two of the four boat-shaped pronghorn images identified at Writing-On-Stone Provincial Park (McCabe et al. 2004:88)

3.3.2 Saskatchewan

3.3.2.1 Gowen I Site (FaNq-25) (Small-Scale Procurement)

Located in south-central Saskatchewan within the city limits of Saskatoon, this Early Middle Period (6000 B.P.) open camp and processing site contains, in addition to bison and other fauna, a small sample of pronghorn remains (Walker 1992). Radiocarbon dates for the site include 5670 ± 135 B.P. (S-1527), 5760 ± 135 B.P. (S-1448), 6065 ± 200 B.P. (S-1488), and 6150 ± 110 B.P. (S-1457) (Walker 1992:182). Based on the analysis

of eruption and wear on bison cheek teeth recovered at the site, the season of occupation was during the late summer or early fall (Walker 1992:103, 143).

At FaNq-25 pronghorn is represented by six fragmented elements. These include a right scapula, left proximal ulna, right proximal ulna, right proximal metacarpal and two distal metacarpal fragments (Walker 1992:99). "The breakage of this material probably resulted from butchering and maximum utilization consistent with the bison portion of the assemblage" (Walker 1992:99). A minimum of one pronghorn is represented at the site.

"The most significant bone tool from the Gowen I (FaNq-25) site is the proximal portion of a right metacarpal of a pronghorn (*Antilocapra americana*) that has a hole drilled into the medullary cavitiy through the center of the proximal articular surface (Figure 3.10). The hole is approximately 13 mm in diameter, and its circumference has been ground to create a smooth, burnished rim. Microscopic analysis of the rim shows numerous striations running parallel to the rim edge" (Walker 1992:66). The shaft of this artifact was fragmented and is represented by at least three pieces.

Two other fragments counted as separate tools may in fact be from the distal end of this bone tube. Both of these specimens are fragments of a bone tube showing cut and polished distal ends. One is a distal metapodial.fragment that terminates at a burnished oblique surface immediately superior to the distal anterior neurovascular foramen (Walker 1992:66-67). The surfaces of these fragments are not fresh, suggesting that the item was probably broken in antiquity and discarded (Walker 1992:67). The function of this bone is unknown, however, Walker (1992:67-68) postulates that it might have been used as a bone flute or whistle, bone pipe or a shaman's sucking tube.

Although bison appear to have been the major food resource, a number of other faunal species were also utilized, including pronghorn. Walker (1992:130) states that the procurement strategy reflected at the site may have involved the ambushing of smaller groups of animals along floodplain margins or oxbow lakes where the animals came to drink.

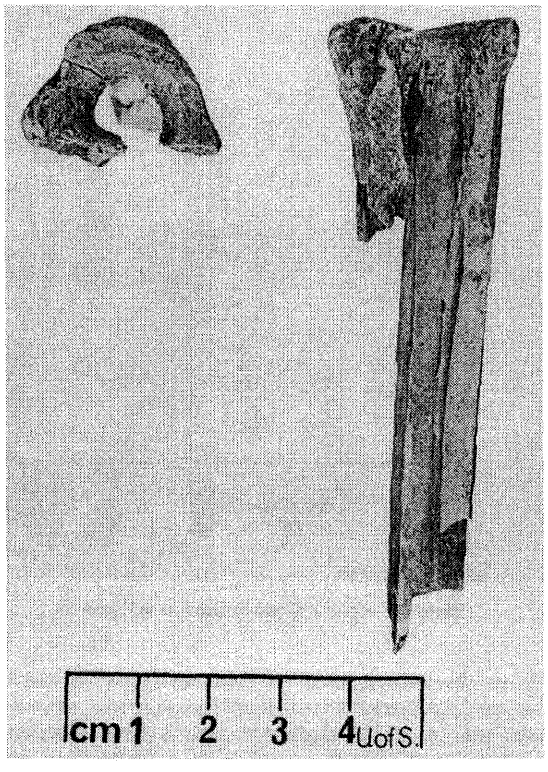


Figure 3.10 Pronghorn bone tube from Gowen I site (Walker 1992:67)

3.3.2.2 Heron Eden Site (EeOi-11) (Small-Scale Procurement)

Heron Eden is a Cody complex bison kill-processing site located in southwestern Saskatchewan. Initial dating was based on the cross-comparison of Scottsbluff and Eden types of Cody complex projectile points (Corbeil 1995:18-21). In addition, radiocarbon samples, retrieved from bison bone specimens, have produced dates of 8930 ± 120 B.P.

(S-3114), 9210 ± 110 B.P. (S-3308), and 8920 ± 130 B.P. (S-3309), establishing additional support for the antiquity of the site (Corbeil 1995:21-22). "The Heron Eden site represents the most northern Cody complex site yet found on the Great Plains" (Corbeil 1995:131). Site seasonality based on bison dental eruption and wear patterns indicates that the Heron Eden bison kill would have taken place sometime during December or January (Corbeil 1995:76).

The Heron Eden faunal assemblage is composed primarily of bison bone (n = 220,164) and the bone bed is generally characterized by a mixed scatter of complete and fragmentary specimens (Corbeil 1995:43), representing the remains of 37 bison. "Other animals, which are associated and considered contemporaneous with the bison bone, include one gray wolf (*Canis lupus*) and one pronghorn (*Antilocapra americana*) (Corbeil 1995:82). A single left pronghorn astragalus (#5018) was recovered at the site, and "due to weathering and bone texture, this element is considered to be contemporaneous with the bison bone bed" (Corbeil 1995:42). This specimen does not exhibit any form of cultural modification. However, based on the date of the site this element is significant in that it helps to establish the early procurement of pronghorn on the northern Plains.

3.3.2.3 Newo Asiniak Site (FbNp-16) (Small-Scale Procurement)

The Newo Asiniak site is located approximately 2.5 km north of the city of Saskatoon, Saskatchewan (Kelly 1986:1). Excavations conducted in 1984 and 1985 established that the area at the base of a cliff contained the remains of two probable bison kills, with no distinct stratigraphic separation (Kelly 1986:44-45).

Based on dentition data and the presence of fetal bone it was determined that the Newo Asiniak kill area actually consists of two stratigraphically inseparable kill events (Kelly 1986:80). The first was a fall kill episode, the other a mid-winter or early spring event (Kelly 1986:80). A second distinct, but associated, area has been interpreted as a processing area with a total of seven distinct cultural occupations (Kelly 1986:5).

The "discovery of side-notched projectile points suggests that the kill event(s) were associated with the Late Prehistoric Period" (Kelly 1986:45). In order to confirm this, radiocarbon dates were calculated using large intact bone samples. One of the samples yielded an age of 185 ± 190 years B.P. (S2763) (Kelly 1986:88-89) which correlates well with the Plains Side-Notched projectile points. In addition the radiocarbon dates indicate the possibility of the site's time depth extending into the Protohistoric period.

In addition to the lithic artifacts, intact and fragmentary bison remains were also present in large quantities (n = 1086) (Kelly 1986:75). There was also a noticeable assemblage of non-bison material. The most numerous of these were the canid remains (n = 97) (Kelly 1986:87). Other species, however, were also represented, usually in the form of "small fragmentary remains which often could only be identified [to] genus" (Kelly 1986:82). These included; *Spermophilus richardsonii*, *Lepus s.p.*, *Mustela*, *Vulpes s.p.*, *Antilocapra americana*, and *Mephitis mephitis* (Kelly 1986:82).

Newo Asiniak is noteworthy because of the similarity between it and a number of other Late Prehistoric period bison jumps with regard to the presence of pronghorn remains. These include; Bootlegger Trail (Roll and Deaver 1980), Wardell Buffalo Jump (Frison 1973b), Glenrock Buffalo Jump (Frison 1970) and Vore (Reher and Frison 1980; Walker 1975). With the exception of pronghorn bone tools, small quantities of

pronghorn elements contained within Late Prehistoric period bison kills are relatively common. This is seen by some researchers as surprising due to the fact that these sites represent the procurement localities of large quantities of bison. Several hypotheses have been formulated in order to explain the presence of these associated pronghorn remains. First, a small assemblage of pronghorn remains might suggest that some camp hunting was going on while the bison butchering proceeded. Therefore, the pronghorn simply served as a change in the menu. The pronghorn remains were simply disposed of by discarding them into the bison kill midden. The other explanation is that a pronghorn herd was grazing with the bison and an unfortunate individual was driven over the cliff during the stampede. Depending on your viewpoint these pronghorn deaths could be seen as either by accident or fortuitously.

Another point of interest is that often pronghorn are seen as a starvation food, due to the high degree of processing found in some site assemblages. Pronghorn remains found intermixed with large quantities of bison remains at the base of a bison jump negates the hypothesis that pronghorn were only procured when no other prey was available.

3.3.3 Additional Sites

Additional sites, containing small quantities of pronghorn remains, are situated across the northern Plains. While space limitations make it impractical to include description of these site their names and site designations are included. Saskatchewan sites are: Sanderson (DhMs-12), Lake Midden (EfNg-1), Estuary site (EfOk-16), Gray site (EcNx-1a), Thundercloud site (FbNp-25), Oxbow Dam site (DhMn-1), Bracken Cairn (DhOb-3), Sjovold site (EiNs-4), Tipperary Creek (FbNp-1), and Amisk (FbNp-17). Alberta sites are: Galt Island Bluff (EaOq-VP), DjOu-5, DgOv-93, Hartell Creek

(EgPi-1), Cluny (EePf-1), and Kenney site (DjPk-1). In Manitoba is the: Stendall site (DkMh-1) (McCabe et al. 2004; Morlan n.d.).

3.4 Conclusion

It appears that most of the northern Plains sites with pronghorn remains are early fall, winter or spring kills, with only one being the result of communal events. The site seasonality is not surprising since during these seasons the pronghorns tend to aggregate into larger herds, and have seasonal nutrition requirements restricting them to specific habitat and specific seasonal movements (migration patterns). What is surprising is that the northern Plains hunters do not seem to have taken advantage of these aggregations to the same extent as in Montana, Wyoming, and South Dakota.

Perhaps just as interesting is the fact that Montana, Wyoming, and South Dakota small-scale kills occur during the early portions of the period (Oyster Ridge, Austin Wash, and 48SW270) with communal kills appearing later; during the Protohistoric and Historic periods (Eden-Farson, Firehole Basin 11, 39FA23). Whether this indeed represents an evolution of hunting practices or is merely a consequence of sampling error is unknown, and is a matter that merits future investigation.

This trend is not reflected in the patterning of the northern Plains sites. In fact, the only known communal kill site (Laidlaw) has been dated to Late Plains Archaic period. Meanwhile, the Late Prehistoric – Protohistoric sites (Saamis, Little Bow Reservoir and Bow Island) all represent pronghorn kills procured through small-scale hunting. Based on these differences there may exist another distinct cultural tradition, pertaining to pronghorn procurement. In fact, unique procurement traditions exist in the Great Basin, High Plains, and now the northern Plains.

Not all procurement strategies used prehistorically in Wyoming and South Dakota could have been used on the northern Plains do to the different topography. Ridges and passes helped to make the communal hunting of pronghorn feasible, while on the northern Plains the landforms made non-communal hunting a more effective hunting technique

Although the evidence for pronghorn hunting in the Historic and Protohistoric periods is relatively abundant and convincing, the data indicating pronghorn hunting in the remote past are considerably sparser and more equivocal. In fact, while large pronghorn bone beds, seen as evidence for communal procurement, are rare across North America, they are non-existent on the northern Plains. In addition, "bone beds do not always represent the actual place of the kill" (Frison 1991b:28). Many of the bone beds that have been found may just as easily represent palimpsests of small kills, as single communal kills.

CHAPTER FOUR

The Modeling of Pronghorn Procurement

4.1 Small-Scale Procurement Methods

Throughout the pronghorn's range various cultural groups developed a number of hunting strategies that enabled them to harvest animals on an 'as needed' basis. As noted by Binford (1980:15), a subsistence system is a positioning strategy that allows a group to respond to resource variation, particularly with regard to seasonal availability, distribution, density, and predictability.

The human hunting repertoire can be seen to include a series of resource exploitation strategies: (1) a single hunter may take a single prey animal; (2) a single hunter may take multiple prey animals through sequential predation; (3) a single hunter may take multiple prey animals through mass predation; (4) a social hunting group may take a single prey animal; (5) a social hunting group may take multiple prey animals through sequential predation: and finally (6) a social hunting group may take multiple prey species through mass predation (Steele and Baker 1993:28).

Kooyman (1990:330) developed a similar conclusion stating that "Hunting any big game species can be accomplished using two basic techniques: communal, where a number of hunters coordinate their efforts (and usually procure a number of animals), and individual, where hunters work in isolation (or perhaps with one or two other hunters), usually to acquire a single prey animal." In addition, Hayden (1981:421) distinguished "small-scale cooperative hunting," involving two to four individuals, from

a "large-scale communal hunting group," involving five or more individuals hunting in a coordinated, cooperative fashion.

Ethnographic descriptions of hunter-gather animal procurement, processing, and consumption have proven to be of considerable value to prehistoric archaeology by providing models relating faunal remains to the behaviour that produced them. (e.g. Binford 1978; Bunn et al 1988; O'Connell et al. 1988; Yellen 1977). Small and medium-sized game has received considerably less attention than large-sized game, as have systems of animal procurement for immediate consumption (Jones 1993:106). There are a number of reasons for this including that small and medium prey are more difficult to recover archaeologically, more difficult to identify; they are often introduced to sites by nonhuman agents and, because of their body size, may be more likely to be thought of as insignificant dietary items (Jones 1993:106).

4.1.1 Pronghorn Behaviour and Small-Scale Procurement

Historic and ethnographic accounts of Plains life combined with archaeological evidence provide a fairly complete picture of how the pronghorn was utilized as a food/clothing source during the prehistoric period. The central purpose of this section is to synthesize the archaeological data with ethnographic and historical accounts in order to reconstruct the processes of pronghorn procurement. By using such an approach, various aspects of the northern Plains pronghorn procurement strategy can be assimilated in order to achieve a comprehensive understanding of prehistoric pronghorn subsistence patterns.

A review of historic and ethnographic sources for the northern Plains suggests that pronghorn were second only to bison in economic importance. They are commonly ranked alongside deer, elk and mountain sheep as an important secondary faunal

resource (Brumley 1983:23). However, not everyone agrees on the past economic importance of the pronghorn. For example Banfield (1974:403) states that "In the Past, the pronghorn was probably not an important economic resource for the Plains Indians because it was difficult to stalk and the thin hide and loose hair made it hardly worth the trouble. Today, however, it is a highly prized trophy of the chase."

In contrast, (Grinnell 1913:189-191) relates how "among the buffalo were yellow and white antelope-many of them-graceful and swift of foot. ... These were the animals which the Blackfeet killed for food before the white men came, and of these the buffalo was chief. ... Yet sometimes it happened that the buffalo went away and that the lonely far travelling scouts sent out by the tribe could not find them. Then the people had to turn to the smaller animals-the elk, deer, antelope, and wild sheep."

There is no doubt that pronghorn were hunted prehistorically throughout their modern range, as amply demonstrated by the presence of culturally modified pronghorn bones in archaeological sites (see Chapter 3). It is the hunting strategy that was employed to procure these animals that is often not immediately obvious. Therefore, it should be assumed that northern Plains pronghorn were taken singly or in small groups by one or more hunters, unless there is evidence for mass procurement that might imply communal hunting. It is difficult, however, to demonstrate even communal hunting in the archaeological record (Driver 1990; Hofman 1994; Lubinski 1997), let alone small-scale procurement. Archeological evidence for communal pronghorn hunting might include concentrations of projectile points, extant trap structures, and pronghorn bone bed sites (Lubinski 1997:69).

While northern Plains groups clearly participated in the communal hunting of bison, other possibilities for faunal resource procurement existed. Many animals could have

been hunted individually. While pronghorn were hunted communally across the central and southern Great Plains, little evidence exists for the implementation of this procurement strategy on the northern Plains. In fact, the majority of the evidence points to the use of small-scale procurement methods for the acquisition of pronghorn.

Pronghorn were taken prehistorically by a variety of methods, from single hunters using disguises to large-scale communal drives of many animals. Both encounter and intercept strategies (Binford 1978) were used to hunt pronghorn. While encounter hunting might be productive, pronghorn behaviour lends itself more profitably to a strategy of intercepting the animal at predictable locations, such as watering holes or migration routes (Lubinski 1999:161). Most of the ethnographic records describe intercept methods, often involving some constructed facilities, such as blinds, cairns, walls, and pits that might leave archaeological traces (Lubinski 1997, 1999).

Prehistoric groups took advantage of the local terrain, habitats, and pronghorn behaviour to facilitate hunting during all seasons. Evidence for this comes from the archaeological data collected from prehistoric pronghorn-kill/processing and trapping locales across the Plains. In many cases, geoarchaeological data can establish landforms used in procurement operations even if they are no longer visible. Landform types are a critical consideration when maneuvering animals, since they may be more willing to move into, or onto, one type of feature than another (Frison 1991b:27-28). Pronghorn for example, are much more comfortable when in an open grassland environment than in a wooded valley. If a hunter should try to maneuver a herd of pronghorn out of their preferred habitat they would surely become skittish and flee.

As stated above, terrain figured prominently in the hunters' procurement strategy (Sanders and Miller 2004). The seasonal movement of pronghorn through geographic

bottlenecks constitutes a predictable annual event. When food resources were predictable, and therefore reliable, they were likely to become a regular part of the prehistoric hunter-gatherer's diet and influence settlement and subsistence patterns, especially if the resource is high value, such as game animals (Winterhalder 1981a). The pronghorn remains at Trappers Point (see Chapter 3) seem to verify this assumption (Sanders and Miller 2004:171).

The following descriptive references involve the pronghorn and some of its unique behavioral characteristics. "He who would study how to pursue the antelope with success must learn the character of the ground which that animal frequents, his capabilities for escape, and the infirmities which beset him. His strength and his weaknesses must be well understood and considered" (Caton 1877:56). "A correct knowledge of their sense of sight, of smell, and of hearing is necessary for success of the hunter, for these should often control his course."

Pronghorn have a number of unique characteristics, as mentioned in Chapter 2 that could have been exploited by the prehistoric hunter. In particular their reluctance to jump vertically, social herding behaviour, avoidance of obstructions, predicable movements, and migration habits are all characteristics that favour hunting by prehistoric groups using various types of small-scale and communal strategies (Arkush 1986; Frison 1971a, 1991a, 2000a; Lubinski and Herren 2000).

Although extremely fast, pronghorn have a habit of running at top speed until they are out of sight of whatever scared them. Then they seem to forget about what they were fleeing from and quickly settle down to graze. Consequently, a single hunter could successfully stalk them (Frison 1978:252). Throughout the prehistoric period, such small-scale hunting must have provided the bulk of day-to-day subsistence requirements.

In contrast, large-scale communal hunts were seasonally restricted, special-purpose events designed to provide large quantities of meat for drying and storage (Landals 1990).

While the pronghorn is a wary and fleet-footed animal it is also extremely curious. Behavioral traits such as curiosity, would have made the pronghorn quite susceptible to small-scale encounter or ambush hunting (Frison 1987:200). Since they prefer open spaces and depend on their vision so they can spot and run away from danger, they must situate themselves in a position with good visibility. As a result, they can be located from considerable distances, particularly in the early and late sunlight hours when light rays are nearly parallel to the ground surface (Frison 1987:200).

"Notwithstanding the large, prominent eye, ... the sight of the antelope is not reliable. He cannot readily identify unfamiliar objects if they are not in full view nor in motion. He cannot readily tell a horse from a buffalo, or a man from a bush, if they are perfectly still, unless they are quite near. They have a curiosity which is very remarkable, and which prompts them to examine every strange object that they see. This completely overpowers their caution, and often leads them into danger and to destruction" (Caton 1877:56-57).

Pronghorn do not hide, as deer are prone to do, and are visible throughout most of the daylight hours. This would have enabled the prehistoric hunter to observe, stalk and track the pronghorn relatively easily. In fact, both modern and prehistoric hunters have used small flags, ribbons, blankets, or even tents to lure pronghorn within bow range, taking advantage of the pronghorn's behavioural trait of curiosity.

This trait did not go unnoticed by aboriginal hunters who would often don a disguise or act in unique ways in order to get within striking distance of the herd. Denig

(1930:535) mentions the Assiniboine using a piece of cloth or blanket to arouse the pronghorn's curiosity and bring the animal into shooting range.

> Much has been said and written of the curiosity of the antelope, and of the modes of taking advantage of the peculiarity by flagging, waving hats, &c. It is undoubtably their most fatal defect of character, though, from lack of skill or patience, I have rarely been able to profit by it.
>
> There is a phase of curiosity peculiar to this animal, which is in itself more remarkable than that ordinary curiosity which it has in common with all plains animals, the black-tail especially; and this has added more antelope to my bag than any of its other characteristics. It is a panic produced by a combination of curiosity and terror. In a country where antelope have not much hunted, they become, as it were, beside themselves at the appearance of any object very unusual and strange.
>
> Thus a waggon train crossing such a country will attract every herd within the range of vision. They will rush at it with every indication of extreme terror, and, passing within a few yards, will sometimes make a complete circuit of the train, going off at last in the direction from whence they came. I have known a few instances where panic was so great that the herd passed between the waggons, although the whole wide plain was open to them (Dodge 1959:196-197).

Another pronghorn trait is that "[a]ntelope possess very great vitality, and will carry off more lead in proportion to their size than any other animal" (Dodge 1959:201). "This animal is remarkably tenacious of life, or if this does not express the exact truth, he can sustain himself for a length of time with such severe wounds as would prostrate almost any animal. With a broken leg he will flee almost as rapidly as if uninjured, and the hunters insist he will maintain the chase nearly as far. They insist he will carry off more lead than any other animal of his size. While undoubtedly the antelope must fall to the shot if hit in a vital part, he can carry severe wounds, and frequently escapes unless these reach some part upon which life or locomotion immediately depends" (Caton 1877:57-58).

The reluctance of pronghorn to cross barriers is well illustrated by Captain Bonneville's account of the manner in which the "Shoshokoe Indians" on the Upper

Lewis River capture the pronghorn. "Sometimes the diggers aspire to nobler game, and succeed in entrapping the antelope ... The most curious circumstance in this chase is, that an animal so fleet and agile as the antelope, and straining for its life, should round and round this fated enclosure without attempting to overleap the low barrier which surrounds it. Such, however, is said to be the fact, and such their only mode of hunting the antelope" (Caton 1877:47-48).

4.1.2 Stalking

The stalk can be considered as one of the primary techniques utilized by northern Plains groups when engaging in the hunting of pronghorn. Ethnographic evidence states that the"[s]talking of game animals wherein an individual or several hunters cautiously approached close to the animals and then killed them is probably the most ancient way of all to hunt" (Arthur 1975:62). Methods of small-scale hunting prior to use of the horse included stalking (sometimes augmented by a disguise), use of decoys, and use of a wide variety of landforms (aided by favorable weather conditions) for small, natural traps.

"In the late winter and early spring, when only a few buffalo were to be found, various means of stalking were employed. A single animal would be tracked and followed until it was exhausted and abandoned the flight. Two men sometimes joined in a relay chase, alternately following the animal until it could run no more. Antelope were also taken by this method. Hunters [also] crawled up to a herd until they were close enough for a sure hit" (Mandelbaum 2001:57). According to William Maycock the successful bow hunt of a pronghorn required that the shaft be put in the chest cavity; otherwise, the result would be another wounded animal requiring time and effect to locate, if location was even possible (Frison 2004:205).

Ewers (1958) notes that the Blackfoot normally hunted pronghorn on foot and that only an exceptional horse was able to catch up with these animals. He goes on to mention that there is no evidence for group hunting of pronghorn on horseback. "The Blackfeet were splendid prairie hunters. They had no superiors in the art of stalking and killing such wary animals as the pronghorn. Sometimes they wore hats made of skin and horns of an antelope head, which were very useful when approaching game" (Grinnell 2003[1892]:241).

> In stalking this animal the Indians show great dexterity. ... This feat is extremely difficult though not impossible in the naked plains, where neither sage-brush or ant-hill is found to conceal the approach, but only the short, sparse grass is found. ... [T]he first step of the hunter who sees his game in the far distance is by describing a wide circle, if need be, to obtain a position to the leeward of the game, so that the odor with which he taints the air may not betray him. Thus, if upon the naked plain, while yet a long distance off, he must get down upon the ground and crawl as close to it as possible, always when moving keeping his eye upon every one of the band, and the instant one of them turns his head towards him stop every movement, no matter what his position may be, till the animal turns away or again goes to feeding. If none of the animals smell him of hear him, or see him move, he may steal upon them and secure a prize. No matter if they do see him, unless they see some motion the chances are that no one of them will recognize him or suspect that the object is anything harmful. They will not notice that they have never before seen an object there on the naked plains. If they see the least motion their fears are instantly aroused, and they dash away like the wind to a safe distance, when they will usually stop and turn round to see what it was that alarmed them. If the hunter still remains perfectly quiet their alarm will not usually subside entirely for some time, but they will soon renew their retreat, though perhaps not at full speed, and if they even go to feeding not far away they are apt to keep a vigilant watch of the object so that it is hardly possible to approach them again (Caton 1877:59).

Stalking involves the hunter slowly working his way to within shooting range. This is a hunting strategy that was perfected by the Plains Indian once the bow and arrow arrived. According to Denig (1930:534), this slow and labourious approach sometimes

required hours to get within shooting range. It must be remembered, however, that a pronghorn moving at even a leisurely pace can quickly out-distance a hunter on foot. If the animal stops along the way to feed or rest, an approach can be made. "[However] it has to be remembered that [during the stalk] the hunter is very much on the pronghorn's terms" (Popowski and Pyle 1982:287).

In order to effectively stalk the pronghorn and get within range the individual prehistoric hunter employed a number of methods. When the terrain was too flat for a close approach or the pronghorn were suspicious, a disguise was necessary. Often "a lone hunter equipped with a bow and arrow would wear a pronghorn skin and head in order to approach a herd of pronghorn. The head would be that of a male, so the hunter could portray a lone buck approaching the herd" (Arkush 1986:242). On the northern Plains, the hunter would commonly utilize a wolf, pronghorn or other skin, as a stalking disguise (Denig 1930:535; Ebeling 1986).

Kelly (1932:82-83) provides an excellent description of the way in which the pronghorn was hunted individually.

> The hunter wore an antelope head with horns attached, and also a hide body disguise. The latter was not necessary for deer stalking, but was required for the more alert antelope. The hunter carried white paint in a sack, and when he approached the animals he smeared it on his face and arms and on his body and legs below the hide covering. He carried a stick about the length of the antelope's leg as an aid in walking and gradually got within shooting range by imitating the movements of the animal, pawing the ground and simulating grazing in order to make the deception realistic.

Addition evidence for the use of a disguise when stalking pronghorn is provided by Beckwith 1978[1930]:920); "There was a [Gros Ventre] man who was very fond of hunting. When he skinned an antelope with pronged horns, he would wear the skin over his body as a decoy and walk up to the herd away from the wind and against the sun and

when he came close he would shoot. Then he would pack the animal home on his back. So they named him "Packs Antelope".

During those seasons when the grass is up, the pronghorn is more easily approached in the middle of the day especially when they have been lying down for an hour or two. Even if the pronghorn are not asleep, their position and the intervening grass reduce their range of vision. Sometimes a combination stalk and ambush is possible.

The above mentioned technique relies heavily on topographic features for concealment (Brumley and Dau 1988). "Research within southeastern Alberta suggests the density of archaeological materials is lowest in areas of level to gently rolling prairie, increasing steadily in areas of greater topographical relief until it again decreases in areas of extreme topographic relief, such as severe badlands areas" (Brumley and Dau 1988:80). The Level Prairie zone is usually composed of ground moraine or glacial lake deposits and it has little in the way of topographical contours. This zone contains only rare and short-lived meltwater ponds (sloughs), but it often provided rich grazing land for bison (Vickers 1989:86). "The topography is not very good for pedestrian hunting, there is no cover, and archaeological sites occur in only low density" (Brumley et al. 1982:54). However, "the Rolling Prairie zone, contains numerous meltwater ponds and good cover for game stalking" (Brumley et al. 1982:55).

4.1.3 Ambushing

In addition to the stalk, the ambush is another technique useful in the hunting of pronghorn. In fact, ambushing the pronghorn at watering holes was a popular tactic used by aboriginal hunters. In the winter the ice and drifting snow around the water source hampered their quick getaway. Mud played the same role during the other three seasons enabling a hunter to get a shot off before the animal vanished over the horizon. Watering

holes usually had tall grasses growing up around the edges and bending over to drink also took away the pronghorn's ability to spot a predator until it was too late.

The modern "bow hunters perhaps use water sites as ambush points more than any other hunters" (Popowski and Pyle 1982:285). In addition, blinds built near water holes are excellent for the bow hunter. One trait characterizing bow hunters is the serious outlook most of them have to their hunting. Many will chart out the number of watering sites in an area and spend days before the season noting which holes are used and where the animals are moving from (Popowski and Pyle 1982). The problem with lying in wait for a pronghorn to amble into view is that it can be a very long wait. "Many hunters would not have the patience or the desire to hunt in this manner. But for an older hunter, or a fellow who wants to take it easy, it will pay off" (Popowski and Pyle 1982:285).

Another form of ambush hunting involves spotting a moving group of pronghorn in the distance. Then the hunter tries to determine where the animals will pass and works his way around the herd to a location in front of the animals. There the hunter sets up a hunting blind just off the trail and well in advance of the moving animals (Popowski and Pyle 1982). Waiting until the herd moves parallel to the blind before selecting and killing an animal. Other techniques of individual pronghorn hunting involved hiding in depressions and behind shrubs next to springs and game trails, from "where a marksman could effectively ambush these animals" (Steward 1943:360).

The migration-intercept strategy of procurement would be an effective strategy for the procurement of pronghorn. As winter storms concentrated the animals and forced them down traditional migration trails to less hostile winter quarters, prehistoric hunters could use both the behavior of the pronghorn as well as the topography to insure a successful ambush. In addition to the seasonal migration routes pronghorn also have

daily preferred travel routes. These will often constitute a trail network running between watering sites and feeding areas (Popowski and Pyle 1982:283).

In addition, pronghorns will not cross barriers such as steep slopes, and rough areas if an easier way around can be found. Therefore, an ambush can be set up along these preferred travel routes. Barrier crossing sites, where an animal has to slow down in order to cross can prove productive for the pronghorn hunter. Also, bodies of water associated with small coulees are good ambush points especially if it is known that pronghorns are frequenting these areas (Popowski and Pyle 1982).

In some areas there are additional types of natural ambush sites. Salt licks can be productive as well as little patches of vegetation that remain green well beyond the average for the area. Pronghorn will frequent these vegetated patches in late fall. Usually an underground spring or seep is found in these areas and they can be especially good areas in which to setup a hunting blind, especially if no other water source exists in the immediate area (Popowski and Pyle 1982:286).

When pronghorns are resting there are always one or two animals staring out across the country, and they quickly note signs of danger. The pronghorn moves while it grazes, lifting its head out of the sagebrush after each bite to see where it is travelling (Popowski and Pyle 1982:288). This action allows the pronghorn to take notice of any suspicious changes to the landscape that might that might indicate a threat. Therefore, while some topographic features may aid the hunter other characteristics make the pronghorn quite difficult to ambush.

4.1.4 Additional Procurement Strategies

Historic journal accounts often state how the lone hunter very seldom had a successful hunt until the arrival of the horse. While this is most likely overstated the

horse did significantly modify the primary hunting strategy employed in the hunting of pronghorn. With the northern arrival of the horse the native population noted that pronghorn tend to run in a circle when pursued. This led to the chasing of pronghorn in relays, killing them as they were slowed by fatigue (Ebeling 1986). "Their tendency to run in a circle facilitated driving by horse relays in the north, where large drives were not undertaken" (Steward 1938:34). "The antelope, when pursued on the plains, is inclined to run in a circle, and thus may be taken advantage of by the horseman keeping well within the circle, and as if attempting to head off the chase, which is sure to provoke the animal to make every effort to avoid the result, which brings his course more in the circular form. In this condition the game must soon succumb, in consequence of the greater distance he has to run" (Caton 1877:5762-63).

Julian Steward wrote of "the propensity of antelope to be drawn by curiosity toward strange objects" (Ebeling 1986:654). This curiosity made them an ideal animal to be victimized by the "surround" style of hunting. Frank Lalter, in this Handbook of Yokuts Indians, tells the story of a successful surround hunt. He "recorded the story of an old Indian who had seen two men lie on their backs and kick their feet, to which they had tied cloths. Antelope came closer and closer, going around the two men in circles, attracted by the waving cloths. In the meantime they themselves were encircled by a group of Indians. Then the two men in the middle began shooting, killing about ten antelope before the others were allowed to escape" (Ebeling 1986:275).

In winter, animals could be trapped in deep snowdrifts or on slick or rotten ice. Due to the lack of dew claws, which reduces its traction and mobility on this slick and uneven surface, the pronghorn is unable to rely on its speed for defense. Bison and pronghorn were slain when the snow drifted into the gullies, forming banks 3 to 4.5 m

(10 to 15 feet) deep. It was during these conditions that the animals were especially easy to pursue using snowshoes (Denig 1930:535). During the winter months deep snow drastically slows and weakens the pronghorn. Also, pronghorn tend to shy away from crossing snowdrifts as they block the animal's line of sight and present a greater risk of being ambushed.

4.2 Archaeological Evidence for Small-Scale Procurement

Archaeological evidence for a small-scale hunting kill site might include a wide range of isolated finds such as lithic flake concentrations, low-density groupings of contemporaneous projectile points, or a single shallow hearth. Generally, this is evidence that gets classified by the archaeologist as an isolated find with little or no follow-up description. The actual stalking and killing of an individual animal leaves little in the way of an archaeological signature. However, the analysis of various differential transportation and carcass recovery strategies may illuminate the unique archaeological signature of the kill site, processing site and habitation site midden faunal assemblage. For example, all elements should be represented in the habitation faunal assemblage if the whole animal is brought back to camp, unless pre- or post-depositional processes are acting on the elements.

Kill sites are generally characterized by the presence of low value bones, hunting weapons, intact or fragmented butchering tools, and a relatively high incidence of resharpening flakes and severed flake scars on tools edges. They are also characterized by an absence of fires, tools used for purposes other than butchering, and secondary processing (Kooyman 1990:335). Kill sites are expected to have a minimum of bone physically removed or mechanically destroyed. These kinds of sites represent food procurement and the initial stages of food-processing. Consumption and other uses of

animal products probably took place elsewhere and involved soft tissue products, not the large, often useless (in terms of food value) bones (Lyman 1982:160). Of course, not all kill sites are multi-component and, furthermore, not all kill sites involved bison. In southern Saskatchewan there should also be pronghorn kill sites although to date none have been found. This may simply be a sampling bias between Saskatchewan and Alberta. In addition, there must be individual kill sites of more solitary animals like deer, elk, and moose they just have not been found or simply leave an unrecognizable archaeological signature (Dyck1983:8-10).

Secondary processing sites usually lack the low value bones often found at kill sites and contain minimal bones of moderate or high value. Some secondary processing obviously occurs and drying racks structures and stone anvils associated with such activities may be present. These sites are likely to have a lower incidence of severed flake scars on tool edges than at kill sites and a higher incidence of unmodified utilized flake tools. While some features of habitation sites may be present, such as hearths, temporary dwellings, and some lithic tool manufacture, most of these features would be absent. Lithic tools would be predominately associated with butchering, and very task-specialized tools such as adzes would be rare or absent (Kooyman 1990:335-336).

The archaeological signature of small-scale hunting is quite distinctive. Large projectile point concentrations may be hunting camps, retooling loci, or favorable ambush locations that were used repeatedly (Lubinski 1999:170). Some stone alignments and hunting blind sites undoubtedly date to the remote past and, as stated above, probably represent single hunters or small cooperating groups rather than large communal ventures.

Habitation sites would usually be characterized by the presence of only high value bones, or a general absence of bones. They would be similar to secondary processing sites in having a low incidence of severed use-wear and retouch flake scars on tool edges and a relatively high frequency of unmodified utilized flake tools. This is most likely do to the fact that "[s]tone for flake tools would probably not be such a limited resource at habitation sites, and it is possible that it would also not be limiting at secondary processing camps" (Kooyman 1990:332). There would probably be evidence of lithic tool manufacture and localized activity areas would be present within the site. Dwellings, hearths, and other indications of domestic activity should be present, although all might not be preserved archaeologically (Kooyman 1990:336).

"Since archaeological evidence for small-scale hunting is rare and perhaps considered to be irrelevant due to the ephemeral nature of both the event and the record it produces, such sites are for the most part unreported, if not unrecognized in the field" (Landals 1990:123). Therefore, finding encounter hunting kills is extremely difficult. Exceptions may occur when a noncommunal kill site is of interest due to its great age, its utility in more general, regional reconstructions, or because it is contained in the numerous unpublished reports generated by cultural resource management projects (Landals 1990). This bias within the archaeological record is in direct contrast to the ethnographic and historic accounts, which contain numerous references to small-scale, encounter hunting (Grinnell 1913, 2003[1892]; Mandelbaum 2001).

"By downplaying historic, ethnographic and archaeological evidence for small-scale hunting strategies, they are rendered less visible, contributing to the continued overemphasis on large-scale, communal hunting strategies. As long as small-scale kills are written off or ignored in favor of the highly visible communal kills, our

understanding of prehistoric subsistence patterns on the Plains will remain unacceptably parochial and biased" (Landals 1990:147).

With regard to small-scale hunting, the pronghorn were simply not as predictable a prey species as bison and, therefore, were generally exploited on an as needed basis and hunted using an encounter procurement strategy. Encounter strategy procurement is the polar opposite of intercept hunting, in which hunters cover large areas in search of low-density, low-predictability game (Binford 1978). This strategy has an extremely low visibility in the archaeological record, producing sites that might best be classified as locations.

The pronghorn, therefore, represents the physically largest, most abundant and most predictable of the low-predictability, low-density prey species on the northern Plains. This placed the pronghorn, prehistorically, into the role of a preferred secondary resource. If bison were not available or a change in diet was desired, a hunter might temporarily switch to the procurement of pronghorn (Frison 2004:255).

4.3 Pronghorn Procurement Technology

The bow and arrow is seen as being a superior weapons system for the procurement of pronghorn, as "the bow provides tactical differences compared to spear or atlatl hunting" (Lubinski 1997:297). "What is striking is that of all the propulsion weapons the bow and arrow was the most capable weapon for hunting small game" (Pyszczyk 2003:67).). In fact, Frison (2004:58) conducted experiments with willow arrow shafts, concluding that while the arrow was unable to penetrate elephant hide, it is adequate for use on smaller animals, such as deer and pronghorn, with their thinner hides.

Was there a greater need for aboriginal people to diversify their food base during the latter half of the Late Prehistoric Period resulting in the increased use of this weapon

(Pyszczyk 2003:67) or is another cultural or depositional process responsible for the pronghorn procurement patterns that are seen in the archaeological record?

It is postulated that the bow and arrow was becoming entrenched as the hunting weapon system of choice in southern Alberta and Saskatchewan by approximately 2000 years ago, through the gradual replacement of the atlatl and darts (Pyszczyk 2003:56). This can be seen archaeologically with the more consistent appearance of small projectile point types in lithic assemblages (Pyszczyk 2003:52). "Dart points and bow and arrow points can usually be distinguished by size" (Frison 1991a:211).

Around 2000 B.P on the northern Plains several point styles overlap, however, the general consensus is that the Avonlea style of projectile point is the most representative of bow and arrow technology, while Besant Phase projectile points are dart points. Even the Besant Phase Samantha points, which are also small, side- notched and contemporaneous with Avonlea, are likely to represent "...high speed, low impact dart points..." (Greg et al. 1996:85). Meanwhile, "all Avonlea points are small and are assumed to be arrow points" (Kooyman 2000:124).

The Avonlea phase is known primarily from the Northwestern Plains and Rocky Mountains of Saskatchewan, Alberta, and Montana, where it is associated with dates ranging from 1700 to 900 B.P. (Cloutier 2004:65; Morlan 1988:296-301; Peck and Ives 2001:164). Avonlea groups generally are thought of as bison hunters, however, there is also one probable Avonlea communal pronghorn kill, the Lost Terrace site (see Chapter 3) in Montana (Davis and Fisher 1988, 1990).

It is not that the atlatl and dart could not have been used to kill a pronghorn. Frison (2004:211), discusses his experimentation with replica atlatls, claiming that they "proved adequate for killing jackrabbits, cottontails, and marmots." He goes on to state

that while he never tried to kill a deer or pronghorn, he was "convinced that with sufficient practice to improve accuracy, it would prove reasonably effective for those animals" (Frison 2004:211).

Compared to spear/atlatl technology, the bow and arrow may have been a more effective killing tool (Blitz 1988), allowing more stealth because it permits projectile release with less movement (Frison 1991a:212; Kelly 1997:28). These tactical differences might have allowed for more efficient individual hunting of pronghorn and explain the observed change in resource utilization that occurred at approximately 2000 B.P. However, it is more likely that this was but one of the factors that contributed to the increase in pronghorn remains at Late Prehistoric period sites. Other factors may have included increased human and/or pronghorn population, cultural migration, an increase in resource value, and finally the introduction of the horse. All these factors may have been in addition to the various taphonomic processes that are discussed in Chapter 5.

With the arrival of the horse, mobility would have been greatly enhanced, and a "base camp strategy coupled with wide ranging search patterns" could have replaced earlier strategies (Reher and Frison 1980:47). This strategy could result in an increase in pronghorn procurement through increased success in finding pronghorn migration routes, or increased success in hazing pronghorn into trap structures (Lubinski 1997). Based on historical accounts, horses reached the northern Plains sometime between A.D. 1650 and 1710 (Ewers 1958). As mentioned above this is was likely one of many factors responsible for the increase in pronghorn procurement during the Protohistoric period.

The bow and arrow provided the technology that enabled more effective and efficient exploitation of Plains fauna, not only communally, but also by small groups or individual hunters (Reeves 1990:170-171). As suggested by Frison (1978, 1991a:211-

212), this missile system was, when compared to the atlatl, more easily manufactured, versatile, and easier to control and use. The bow and arrow has more rapid firepower, greater range and accuracy. It can be used in situations where the atlatl cannot. "One might liken the benefits made possible by adoption of the bow and arrow to the introduction of the repeating rifle in our culture in the 1870's; this replaced the single shot, our technological analog of the more ancient atlatl" (Reeves 1990:171).

The focus here has been to highlight a number of plausible explanations for the changing patterns of small-scale pronghorn exploitation. Invention or improvements in hunting technology and the introduction of the horse stand as some of the most visible examples of factors that might have influenced the degree to which pronghorn were procured.

4.4 Optimal Foraging Theory and Pronghorn Procurement

Optimal foraging theory grew out of a number of different models and was adopted into archaeology and anthropology from biology (Bettinger 1991:83). Optimal foraging or least-effort theory was developed through the observation of faunal feeding habits by ecologists and has gained exceptance among archaeologists due in part to the work of Winterhalder (1981b). This theory might just as easily have been borrowed from microeconomics as one of its principle tenets attends to the rational decision making of individuals under a set of specified conditions. These conditions include limited resources and unlimited needs, as well as their effects on the range of choices available to consumers (Bettinger 1991:54).

The archaeological version of optimal foraging theory asserts that in certain arenas, human decisions are made to maximize the net rate of energy gain (Bettinger 1991:54). These situations include choices of diet (unconstrained and constrained dietary breadth),

foraging location (Patch Choice), foraging time within the patch (Marginal Value Theorem), and settlement location (Central Place Foraging). The above mentioned interaction theories are all grounded in ecological and optimal foraging theory. However, while they may focus on the relationships between human groups and natural resources it must be emphasized that this interaction is not always due to resource stress as a causal agent.

While it is my intent to apply the model, not just explain the theory, it is still worthwhile to review the basic premise of optimal foraging theory. Optimal foraging theory refers to the maximization of benefits versus the costs of acquisition, within the context of food procurement. This cost-benefit ratio is usually expressed in terms of the nutritional values of prey species (calories, protein, fat) countered by the energy expenditure in the acquisition of the food resource. Optimal foraging theory equates subsistence aims with cost-benefit analysis that is related to high yield and least-effort models of procurement strategies.

The least-effort assumption can be restated as the following hypothesis: the primary goal of prehistoric people was to procure an adequate nutrient intake at the lowest possible labour cost. The least-effort hypothesis, as stated above, presupposes rationality in goal formation and knowledge of the availability, costs, and nutrient value of resources. Nevertheless, the utility of the model of optimal resource use presented here does not depend on the reality of the assumption that prehistoric people understood the nature of specific human nutrient requirements, nor that they had knowledge of the precise nutrient value of resources. Investigative models such as diet breadth provide a means to explore the differential use of various taxa by hunters. The diet breadth model of foraging theory is now routinely used in zooarchaeolgical analyses of precontact

hunting behaviour (e.g. Broughton 1994, 1999, 2002; Cannon 2000, 2003; Janetski 1997; Nagaoka 2002).

In this thesis the diet breadth model will be used specifically to explore the diet choices of northern Plains hunters with respect to the procurement of pronghorn as compared to that of bison and deer. Perhaps pronghorn remains are only found in small quantities at northern Plains sites because the pronghorn was not a very viable subsistence resource? Utilizing the diet breadth model will indicate the extent to which the pronghorn should be placed into the northern Plains prehistoric diet

The diet breadth model defines what set of food items foragers should eat, based on costs and returns of each particular food resource. More specifically, it predicts hunting and gathering activities as food resources are encountered and decisions are made as to whether or not to procure food item and either continue the subsistence search or end it.

Hunter-gatherers can be generalists (consuming a diverse set of food types) or specialists (consuming a restricted range of food types) (Winterhalder 1981b:23). Specialists tend to bypass numerous potential prey in favor of higher-ranked resources. The quintessential generalist, on the other hand, would exploit all or nearly all prey encountered (Waguespack and Surovell 2003:348).

While the prey model considers the amount of time involved in handling a food resource (e.g. pursuit, capture and processing) it does not consider the amount of time engaged in searching. Food resources are ranked based on energy expenditure in their acquisition against the caloric benefits of consuming the food resource. High ranked resources minimize the amount of energy expended in acquisition against the amount of energy gained by their consumption.

Three of the most straightforward predictions of the prey model are: 1) individual subsistence resources will always either be exploited or ignored; 2) the caloric value of a subsistence resource is not the sole determinant of exploitation; other costs such as, search, pursuit and handling time are also factors; and 3) the inclusion of lower-ranked food resources in the diet depends not on their own abundance, but rather on the encounter rate with higher-ranked food resources. It follows that increases in the encounter rate with high-ranked food resources should cause an increase in the overall return rate and a general narrowing of the diet to include fewer lower-ranked food resources (Stephens and Krebs 1986).

The idea of using the efficiency index as a proxy for other descriptive methodologies presented itself while reading Roll and Deaver's (1980) *The Bootlegger Trail Site: A Spring Bison Kill*, for inclusion in Chapter 3. Their unique but highly functional methodology appears to be a good match for the analysis being conducted here.

The efficiency of hunting different taxa and using different procurement strategies, can be calculated. Table 4.1 lists three of the Plains ungulates that were utilized prehistorically. The adult live weight ranges for the various species were provided by Banfield (1974) and Mitchell (1980). Average live weights were collected from data published in both Banfield (1974), McCabe et al. (2004) and White (1953b). As carcass weight is a ratio of live weight it can be represented as a percentage of live weight. It is calculated here on the premise that 90% of dressed carcass weight (minus most bones), plus 60% of viscera will produce a number in the range of actual food utilization figures of carcasses by precontact Plains groups (McCabe et al. 2004). These percentages were then cross-referenced with White's (1953b) publication in hopes of reducing the

likelihood of error. The caloric content figures for the various species are taken from USDA (2004).

Taxa	*Bison bison* (Bison)	*Antilocapra americana* (Pronghorn)	*Odocoileus hemionus* (Mule Deer)
Range of Adult Live Weights [a]	360 - 720 kg	46.5 - 70.3 kg	31.5 - 215 kg
Average Live Weight [b]	420 / 570 kg	50.5 / 56.4 kg	61.8 / 74.8 kg
Whole Body Weight [c]	327.6 / 444.6 kg	44.8 / 49.7 kg	53.7 - 65.8 kg
Average Field Dressed Weight [d]	275.2 / 373.5 kg	34.5 / 38.3 kg	41.9 / 51.3 kg
Food Yield Percentage [e]	68%	57%	70%
Average Food Yield	222.8 / 302.3 kg	25.5 - 28.3 kg	37.6 - 46.1 kg
Energy [f]	1660 kcal/kg	1140 kcal/kg	1200 kcal/kg
Calories Available per Individual	369,848 / 501,818	29,070 / 32,262	45,120 / 55,320

[a] Banfield 1974; Mitchell 1980

[b] Banfield 1974

[c] Marchello and Garden-Robinson 2003

[d] Benson 2004; Field et al. 2004

[e] Benson 2004; Field et al. 2004; McCabe et al. 2004; Mitchell 1980

[f] USDA 2004

Table 4.1 Weights and calories available from select northern Plains mammals (Adapted from Roll and Deaver 1980)

The final row in Table 4.1 shows the potential caloric return for the procurement of a single individual of each species. However, these figures are meaningless without assessing the effort expended and the difficulty in obtaining each animal type. The effort

expended to obtain a single individual was calculated by measuring the round trip distance to kill and retrieve the animal.

Taking the above mentioned behaviour as well as ethnographic evidence into account, pronghorn are given a success ratio of 1 kill in 4 attempts. Based on the deer's behaviour, and the fact that they are less abundant, a success ratio of 1 in 5 is assigned. Bison were probably more abundant and less wary than pronghorn due to their larger size, they were more likely to suffer nonfatal wounds. A success ratio of one in two seems more justified and compares favorably with the ethnographic success ratios for the hunting of large herd animals. Success ratios probably varied seasonally, therefore, these are intended to represent a yearly average.

Combining estimates of round trip distance, success ratio, and number of hunters per attempt results in an approximation of the caloric investment to obtain a single individual of each species. The caloric expenditure in hunting is little more than the calories used in walking to and from the place the animal was killed. That number of calories usually accounts for the expenditure in obtaining and utilizing an animal. Most animals can be carried back by the hunter(s) that killed it. However, for the bison, the animal is simply too large for the hunters to retrieve. Bringing an entire bison back to camp (presence of all skeletal parts evidences that all butchering occurred there) would entail dispatching extra bearers whose caloric expenditures must be added to those of the hunters. Table 4.1 presents the total estimated calories expended to kill and retrieve each species. Table 4.2 shows the efficiency of communally procuring bison and pronghorn, based on two archaeological examples. Finally, in Table 4.3 an efficiency index for small-scale procurement is calculated for each species. This is done by dividing the calories per carcass calculated in Table 4.1 by calories expended to kill and retrieve a

single individual. This index represents the number of calories obtained per calorie expended if the group sought to hunt this taxon as its only source of food.

Sites	*Bison from Bootlegger B, Level I*	*Bison from Bootlegger B, Level II*	*Pronghorn from Eden-Farson*
People Participating	150	150	75
Travel Calories Expended	600,000	600,000	300,000
Set up Kill Calories Expended	300,000	300,000	150,000
Calories to Process Animals	150,000	150,000	75,000
Total Calories Expended	1,050,000	1,050,000	525,000
Adult Animals Killed	471	866	212
Kilograms of Fresh Meat Used	106,006	137,886,	3,946
Kg of Fresh Meat Eaten at Site	3,000	3,000	1,500
Kg Dried Meat Eaten Later	10,300	13,488	247
Calories of Fresh Meat Eaten	7,500,000	7,500,000	3,750,000
Calories of Dried Meat Eaten	20,909,000	27,380,640	501,410
Total Calories Utilized	28,409,000	34,880,640	4,251,410
Efficiency Index	27.1	33.2	8.1

Table 4.2 Efficiency for communal hunting of select northern Plains mammals (Roll and Deaver 1980)

All of the figures presented so far deal with the hunting of a particular taxon by single hunters or small groups. As is evident in Table 4.1 bison provide the most calories per individual with mule deer second and pronghorn third. This is not surprising as available

calories are strongly reliant on animal size. Table 4.2 addresses the viability of communal pronghorn procurement as it compares to communal bison procurement.

Taxa	*Bison bison* (Bison)	*Antilocapra americana* (Pronghorn)	*Odocoileus hemionus* (Mule Deer)
Population Density	6/1 km^2	4/1 km^2	2/1 km^2
Success Ratio	1/2	1/4	1/5
Minimum Number of Hunters	2	1	2
Calories Expended per Animal	6,000	2,000	5,400
Addition Calories to Retrieve Kill	4000	0	0
Total Calories	10,000	2,000	5,400
Efficiency Index	50.2	16.1	10.2

Table 4.3 Efficiency for small-scale hunting of select northern Plains mammals (Roll and Deaver 1980)

The inclusion of bison and pronghorn within northern Plains faunal assemblages indicates that the mobility, procurement strategies, and technologies of the prehistoric inhabitants of the region were geared towards the procurement of these two species. These species were the predominant ungulate resources in areas exploited by the prehistoric inhabitants of southeastern Alberta and southwestern Saskatchewan; however, while both species were available, bison appear to have been taken preferentially. The efficiency indices that were calculated in Table 4.3 provides further evidence to support this conclusion and demonstrate that is was in fact a rational decision.

Based on Table 4.1 bison ranks the highest of the ungulates most often encountered in northern Plains faunal assemblages, assuming that body size (calories per individual) correlates with rank. According to the diet breadth model, if bison were abundant within the foraging range, bison should have been hunted to the exclusion of other, smaller animals, such as pronghorn.

Hayden (1981) offered one explanation for the occurrence of communal pronghorn drives even though they appear to be quite inefficient compared to bison drives. He noted certain inefficiencies in communal hunting methods, and suggests that communal tactics are a response to particular sets of environmental conditions. One example of this might be the communal procurement of pronghorn at the Lost Terrace site (Davis and Fisher 1988). Here the procurement is "interpreted as a response to an anomalous, life-threatening winter food-provisioning problem situation" (Davis and Fisher 1988:101). Perhaps the Laidlaw Antelope Trap (DlOu-9) in southeastern Alberta also functioned in a similar capacity.

The efficiency indices clearly show that while bison are a more efficient subsistence resources pronghorn are in fact a highly ranked secondary subsistence resource. The premise of this section was to explore the hypothesis that pronghorn were a viable, highly ranked secondary food resource on the northern Plains. The above research does illustrate that the pronghorn was a viable food resource and that in regard to the northern Plains it was much more efficient to procure pronghorn on a small-scale basis than communally.

4.5 Summary

As the evidence gathered in this chapter indicates the small-scale procurement of pronghorn is both an efficient and plausible method for the prehistoric procurement of

the pronghorn. Taking the animals behaviour and habitat into consideration, combined with an effective hunting weapon technology, and knowledge of the regional topography, the acquisition of pronghorn as an often-utilized resource becomes a viable prehistoric undertaking. If there is one single truth that has to be admitted about pronghorn hunting, it would be that sometimes it is extremely easy, and sometimes it is extremely difficult" (Popowski and Pyle 1982:253). In fact, "All things considered pronghorn are easy to hunt" (Frison 1991a:240).

As stated above, pronghorn are creatures of habit and appear regularly at waterholes. The hunter can either stalk the animals or ready an ambush in a good location and let the animals come to him. Having established that pronghorn were hunted by a variety of single hunter and small group methods an examination of the resulting archaeological signature is of value. In some cases these methods involved constructed facilities that could have survived in the archaeological record. For example, pronghorn were driven past "ambushed" hunters hidden in brush or stone blinds (Lubinski 1999:161). Drive lines or V-wings might also have been constructed to help direct the game past the concealed hunter, as was the case in the Great Basin (Simpson 1869:52-53; Regan 1934:54; Steward 1943:360). Some of these stone features including the drive lines may still be present on the prairie landscape.

In other cases little if any archaeological signature remains to indicate a pronghorn procurement event took place. One example of this are the numerous kill sites associated with small-scale procurement strategies and the fact that in most cases they will remain undetectable or misinterpreted by archaeologists.

Finally, the above evidence for small-scale hunting of pronghorn on the northern Plains is supported by various ethnographic and historic accounts. These supporting

statements add additional validity to the small-scale procurement model being proposed here by helping to bridge the time gap that exists between the archaeological record and the archaeological episode.

CHAPTER FIVE

Bone Survivorship

5.1 Introduction

Are the patterns found in archaeological pronghorn assemblages truly representative of prehistoric human behaviour? Two possible non-cultural explanations for the patterns observed in the archaeological record might be a sampling bias and/or a taphonomic bias. Several types of sampling biases are present. These include geographic or a differential site discovery and site specific biases. The first refers to the fact that archaeologists may target specific areas in which to carry out research. Generally this has been the result of development pressures or specific research goal. Whatever the reasons dictating the sampling methodology, this bias can often have an effect on the data patterns. If the sites simply have not been located, then the data from which conclusions are drawn represent an incomplete picture.

The second bias deals with the general inability of the archaeologist to excavate the entire site, therefore, a bias is introduced through the partial sampling of the site. Again, the conclusions made regarding the site's faunal assemblage are drawn from incomplete datasets. Fortunately, although these effects cannot be completely overcome archaeologists can do their best to insure a statistically relevant sample is collected. Sites that do not meet these criteria must be used with caution and resulting conclusions must take these problems into account.

The final bias involves the effects of various taphonomic processes on the faunal assemblages. For example, it is possible that pronghorn bones are more susceptible to destruction than other taxa, and that differential destruction accounts for the observed patterns. There is no doubt that, in general, archaeological bone assemblages vary in part due to the effects produced through selective bone transport, cooking and eating practices, disposal practices, bone burial, post-depositional destruction, and archaeological recovery methods. Therefore, interpretation is complicated by the interaction of these factors (Binford 1981; Binford and Bertram 1977; Lyman 1984). While it is not practical to control for all of these factors it is practical to recognize their existence and modify conclusions accordingly.

Differential destruction of pronghorn elements represents a plausible explanation for the patterning of the assemblage. This is based on the fact that more recent sites have had less time than older sites for bone destruction through *in situ* chemical decomposition, root penetration, frost action, and erosion resulting in re-exposure at the surface, as well as other taphonomic effects. As Lubinski (1997:119) has noted:"It is possible that pronghorn remains are differentially destroyed relative to larger animals and that this results in fewer pronghorn relative to other larger taxa in the earlier part of the record." The size bias is plausible because several studies (Kreutzer 1992; Lyman 1982, 1984) have shown a tendency for less dense bones to be more easily or quickly destroyed, or rendered unidentifiable, than denser bones.

During the life cycle of a faunal element a number of different taphonomic processes act upon it to create the final artifact that is unearthed and taken back to the laboratory for analysis. It is these biostratinomic and diagenetic forces, such as carcass processing, carnivore attrition, trampling, and weathering, and the marks they leave behind, that are

the clues archaeologists must use to answer procurement-oriented research questions. When examined in their entirety, these data reveal evidence of the possible role cultural agents and their modifiers had on the faunal assemblage. These forces can be as complex as the initial butchering of the faunal assemblage or as simple as the accidental modification of a bone fragment in the laboratory.

The purpose of this chapter is to identify a number of possible causes, both cultural and natural, that contribute to the final configuration of the various northern pronghorn bone assemblages. These descriptions will ultimately be combined with their appropriate ethnographic and archaeological signatures in order to reveal the relationship between the procurement of the pronghorn, the processing of the carcass, and ultimately the creation of the archaeological record.

5.2 Taphomonic Overview

The archaeological record is not a uniquely human-created phenomenon. Rather it is the result of a combination of cultural and natural processes acting upon both culturally and naturally created material (Lyman 1992). These processes are referred to as taphonomic factors and defined by paleontologist, I. A. Efremov (1940:85) as the study of the transition, in all of its details, of animal remains from the biosphere into the lithosphere. More directly stated, taphonomy is "the science of the laws of burial" (Lyman 1994b). A taphonomic explanation of the remains of past cultures is oriented toward the geological processes, which have affected those materials through time. Taphonomic processes may modify evidence in numerous ways, and must be taken into consideration in any ordered, scientific inquiry into the meaning of a particular set of archaeological data.

Taphonomy encompasses both biostratinomic effects, natural processes affecting an organism between death and final burial, and diagenetic, post-burial, agents. These effects can distort or mimic the cultural patterns of bone modification. It is therefore essential that an attempt be made to identify the causes of modification and establish the level and nature of post-depositional taphonomic change. The interpretation of any faunal assemblage include identification of those modifications that are natural and those that are cultural in origin. Not only the type of modification but also the nature of its effects are important clues to the taphonomy of the bone (Lyman 1994b).

Taphonomic modifications occur at all stages from the initial procurement and food or tool preparation, throughout deposition, and often during recovery of the archaeological material. Usually several taphonomic factors contribute to the final faunal assemblage composition. Bone modification can result from butchering or food preparation as well as trampling, weathering and carnivore attrition. In fact, the taphonomic signature resulting from the cultural breaking of elements to extract marrow is the subject of much research associated with bone modification.

Pre-depositional or post-depositional taphonomic processes as well as transportation decisions regarding faunal elements affect bone frequencies and survivorship in the archaeological record. To whatever extent survivorship is conditioned by volume density, the processes that destroy bone (eg. deliberate fracturing, carnivore gnawing, trampling and weathering) operate directly on anatomical elements and indirectly on whole carcasses or skeletons (Morlan 1994a:804). Therefore, these processes represent the taphonomic factors that zooarchaeologists should be most concerned about, as they are the ones that most directly influence the validity of any conclusions that are drawn.

Determining which process, differential transport or differential destruction is responsible for the structure and content of a bone assemblage is another taphonomic problem. This said, the transport and destruction of skeletal portions have the same effect on bone assemblages; they control the frequency of portions found within a bone assemblage (Lyman 1985:226). Four lines of evidence have been argued to account for the differential transport and/or differential destruction that has affected a bone assemblage:

1) Differential quantitative representation of skeletal parts, interpreted with the aid of the modified general utility index and/or bone density.
2) The degree of disarticulation, fragmentation, and scattering of bones.
3) The geological context of the bones; that is, the question is asked given the evident geomorphic processes.
4) The presence or absence of butchering marks and carnivore gnawing marks (Lyman 1994b).

As hinted at in the first line of evidence, the ability of a bone part to withstand, or to survive, destructive forces is a function of bone density and structure and is one of the lines of evidence taphonomists have developed for evaluating bone survivorship. Lyman addresses this in his statement; "the density of particular bones affects their survivorship and creates patterns and variability in the fossil record" (Lyman 1984:260). In fact, taphonomic mechanisms are thought to be mediated by bone density, size, shape and weight.

5.3 Bone Density

In recent years, increased awareness of the complexities of site formation and disturbance, differential bone survivorship, and bone modification has brought

taphonomic issues to the forefront of zooarchaeological research. The efforts of past researchers (Binford 1981, 1983; Behrensmeyer 1984; Klein and Cruz-Uribe 1984; Lyman 1987) have resulted in wide recognition that the quantitative and distributional characteristics of archaeological faunal assemblages are strongly influenced by non-cultural processes. These characteristics are rarely a direct reflection of the human behaviour that produced the faunal assemblage, or of the original ecological community from which the assemblage was drawn (Binford 1981; Grayson 1984). Natural destructive and attritional processes acting differentially upon skeletal parts can produce quantitative patterns that are often attributed, in error, to butchering and transport of carcass parts. The problem then becomes one of identifying cultural and natural variability among faunal assemblages.

It is also critical to consider the durability of elements and element portions when selecting elements to establish a count of the minimum number of individuals (Klein and Cruz-Uribe 1984). Denser elements and denser element portions are more likely to survive and provide better estimation of the "maximum" minimum number of individuals than less dense parts. Side, sex and age differences in bone density may also alter survival of skeletal remains of some animals within the assemblage. Awareness of these factors allows archaeologists to better reconstruct past procurement strategies and subsistence patterns.

Previous studies (Voorhies 1969; Behrensmeyer 1975; Binford and Bertram 1977) have determined that bone density is but one of the many characteristics of an element that are influenced by taphonomy. In fact, properties such as bone structure, morphology and size, also control bone survivorship but to a lesser degree. This is supported by Lyman's (1982) model, which provides evidence that bone density mediates the effects

of at least some taphonomic processes. "The state of preservation of animal bones is largely determined by the initial size of the pieces" (Uerpmann 1973:307). In a strict sense, a fragment may be weighed no matter how small it is, but because pieces of different size preserved differently (Binford and Bertram 1977; Noe-Nygaard 1977) and recovered differently (Watson 1972) and because it is more difficult to identify the species of smaller fragments it would seem that the degree of survivorship would indeed skew the faunal sample (Lyman 1979). "Preservation does alter bone frequency patterns, survivorship, to the point where the data are distorted. Bone density measurements do track these changes accurately and can be used to overcome these preservation problems to a considerable extent" (Kooyman 2001:292).

Several theoretical discussions have developed over the interpretation of body segments, butchery units, and utility indices (Gifford-Gonzalez 1989; Lyman 1992, 1994b). These discussions serve to reinforce the concept that relative bone density is important for predicting which elements should survive, understanding the absence of specific elements, and interpreting the events which may have affected preservation between the time of death and the eventual recovery and analysis by the zooarchaeologist.

Element frequencies can also reflect the differential destruction of softer, less dense skeletal elements by attritional processes, including natural decay, gnawing by predators or trampling, as discussed below. The most easily destroyed bones tend to be those which are the least compact and lowest in bulk density (Grayson 1989; Klein 1989; Lyman 1984, 1985). The under-representation of low-density elements need not be a sign of the operation of non-human agents. As shown by Lyman (1985) there is a weak negative correlation between Binford's Modified General Utility Index (MGUI) (also

see Binford 1978) and bulk density, based on measurements of deer bones. In other words, elements that are most susceptible to loss or decay through carnivore attrition or natural processes also happen to be parts of high utility, which are likely to be transported away by humans. Metcalfe and Jones (1988) proposed a simpler version of Binford's MGUI index, called the Food Utility Index (FUI). The FUI shows a somewhat clearer, though still weak, negative correlation with bulk density.

One would expect that a low but significant positive correlation should be found between true density and survivorship, and that a high and significant positive correlation should be found between bulk density and survivorship. It is expected that a particular taphonomic agent will more or less equally affect bones of comparable density while another set of bones of different density will be affected differently by the same taphonomic agent.

Density models, constructed by using the rank order patterns of bone density values, were found to be a promising way of investigating taphonomic loss in zooarchaeological assemblages (Ioannidou 2003). To date these models have been extensively used as an alternative explanation for bone assemblages that exhibit patterned reverse utility curves, where carcass utilization practices such as those described by Binford (1978) and others (Brink 1997; Emerson 1990) are found to be inapplicable.

Although bone density values have long been used in archaeological interpretations, the introduction of technology specifically designed to non-destructively determine bone density has permitted its use in more widespread applications. These methodologies allow for direct assessment of bone elements and element portions and enable us to address the taphonomic implications of variation in bone mineral density. However, the early attempts to measure the bone density of sheep/goat by Brain (1969) and

Behrensmeyer (1975) produced incompatible results due to the differences in their respective methodologies (Lam et al. 2003).

Lyman (1992, 1993) indicates that before the role of human selectivity as a force in causing patterns of element frequencies could be addressed, better understanding of alternative, equally valid, processes of structuring assemblages were required. Differential bone survivorship as it relates to bone density is one of those processes that warrant investigation. Lyman (1982) attempted to address this problem by utilizing photon densitometry in his bone density research. A single photon absorptiometer was used by Lyman (1982, 1984) to calculate the densities of bone matrix in deer and pronghorn elements and correlate these with the survival of element portions. This technology enabled him to take readings of bone mineral content along the very narrowly defined areas (scan sites) of each skeletal element (see Appendix E). In his study of deer and pronghorn bone density, Lyman (1984) published density values for scan sites distributed throughout the mandible and the entire postcranial skeleton for the deer. He also generated the values for a partial postcranial pronghorn skeleton (Lyman 1982). These data have become an essential component of many subsequent zooarchaeological analyses.

To date the following northern Plains animal species have density measurements available: deer (*Odocoileus* spp.) pronghorn (*Antilocapra americana*) (Lyman 1982, 1984, 1994b), bison (*Bison bison*) (Kreutzer 1992), and leporids (*Sylvilagus floridanus* and *Lepus spp.*) (Pavao and Stahl 1999). In addition, density data for fish (Butler and Chatters 1994) and bird species (Dirrigl 2001) have been published. These works focused attention on the intrinsic properties of bones as determinants of their survival.

Lyman (1982:75) defines bone density as "the ratio of the mass of a substance to its volume." In addition, it has been established by Lyman (1984) that bone density, particularly bulk density (mass/volume of the solid including pore space volume) as opposed to true density (mass/volume of the solid only), is a crucially important variable in taphonomy to evaluate the utility of differences in the density of various elements by explaining variability in bone survivorship. "The relationship between the volume density of skeletal parts and the utility of those parts for human consumers seems to be tightly dictated by functional anatomical principles" (Lyman 1992:18). Porosity also logically seems an important variable because it is merely an expression of the ratio of surface area to volume (Lyman 1994b). The more surface area exposed to differential destruction the lower the survivorship of the bone. This is particularly relevant when dealing with the survival of fragmented long bone epiphyses. These spongy portions of bone with lower bulk densities contain the most blood and marrow and are structurally weaker than parts with higher bulk density, such as long bone shafts. Consequently, the least dense portions would be destroyed first. With reference to bone density, it is also the weight to volume ratio (the ratio of spongy to compact bone or ratio of mass of a bone to its volume) that Lyman (1984:262) emphasizes as having an affect on the survivorship of bone.

Lyman (1982, 1984) has argued that bulk density may be the property that acts as the strongest mediator of taphonomic mechanisms. The successful statistical application of the equation of bulk density indicates that bulk density is truly a robust indicator of bone survivorship based on the fact that even though its true value may be obscured by other factors it still retains good predictive properties (Lyman 1984).

Bulk density is the measure of the mass of the bone divided by the volume of the solid including pore space volume, measured as g/cm³, and expressed by the formula:

$$D_b = \frac{M}{V_t}$$

where D_b is the bulk denisty, M is the mass and V_t is the volume, including the pore spaces. Bulk density cannot be determined with photon densitometry and thus measurements are of true density as defined by:

$$D_t = \frac{M}{V_s}$$

where D_t is the true density, M is the mass and V_s is the non-porous volume and is measured as g/cm^2 (Lyman 1984:270). A proxy measure of bulk density can, however, be derived from the measures provided by photon densitometry and is referred to as Volume Density (VD) (Lyman 1984:273). VD was obtained by dividing the bone calcium mass (recovered using the photon densitometer) by the width of the bone at the scan site and provides a value for linear density (LD_l) in g/cm^2. When LD_l is divided by the measurement of bone thickness the resulting value is VD (g/cm^3), the same as bulk density. VD is a measure commonly used in zooarchaeological taphonomic studies (Lyman 1982, 1984).

Lyman (1982, 1984, 1987, 1989, 1993) has tested the above model on a variety of archaeological faunal assemblages from North America and Africa, including three that contained pronghorn remains. It is important to note that the three North American pronghorn assemblages all correlated positively with density (Lyman 1993:335). He has taken these results and compared them with some of the African data in an attempt to identify what effects cultural influences have on bone survivorship relative to prey size.

Lyman's (1993) conclusions suggest that the pattern shown by the African data may be a function of the wide range of available body sizes of ungulates on that continent. That is, African organisms (whether hominid or hyaenid or whatever) may have selected bones of larger taxa instead of bones of smaller taxa for extraction of within-bone nutrients because they had several size classes to choose from, whereas North American organisms had fewer size classes (> 84 kg and < 84 kg) from which to choose (Lyman 1993:335-336).

The ramifications of this statement for faunal analysts on the northern Plains is that mixed species assemblages (e.g. bison and pronghorn) may result in less damage to the pronghorn elements from within-bone nutrient extraction. However, in an assemblage dominated by pronghorn elements the damage would be quite extensive due to the lack of nutrient rich long bones from larger size-classed mammals.

As discussed above, differential bone density must be considered when interpreting archaeological events, such as pronghorn procurement and processing. It is apparent that taphonomic context involves a variety of forces and processes, which in turn influenced by both the extrinsic and intrinsic variables responsible for element and element portion survival. These taphonomic effects include carcass processing, exposure, decomposition, scavenging and burial. Variables intrinsic to the bones, which may affect survival, include element density, size, position (e.g. proximal-distal), and shape, and the animal's sex, age, and health. It is the purpose of this analysis to demonstrate the association between one intrinsic variable, density, and element and element portion survival.

This understanding will provide more accurate predictions regarding which elements and portions of elements should survive. In addition, it should also help interpret what the presence or absence of specific elements and element portions means, and aid in the

reconstruction of the events that transpired between death and the eventual recovery and analysis of the remains.

5.4 Natural Processes Affecting Bone Survivorship

5.4.1 Carnivore Attrition

Throughout prehistory animals, especially carnivores, were involved in the scavenging of culturally produced kill and processing sites. It would be naïve to believe that scavengers did not have access to these areas, particularly after human abandonment.

Carnivores are primarily interested in the flesh, which is still attached to a bone after butchering, and will not preferentially chew on a bone unless all other parts have been exploited (Garvin 1987:83). Only after the residual meat, ligament and cartilage is consumed will a carnivore begin the task of marrow extraction. If it remains energetically profitable for a carnivore to continue exploiting a bone for marrow the animal may in fact destroy it in the process (Garvin 1987). In a case where cultural exploitation of the marrow has occurred prior to discard resulting in only bone fragments available for scavenging, a hungry carnivore may simply consume the fragments.

It is this manipulation, removal, and destruction of a pre-burial faunal assemblage that is of interest to the zooarchaeologist. In fact, even if a carnivore's feeding activities do not destroy a bone or bones within an assemblage, it does remove preferred items from association with other bones. The end result of this activity is the removal of a particular bone or bone type from the sample. This scenario, combined with other cultural and natural bone degradation phenomena, will result in a greatly diminished faunal assemblage from which to draw cultural inferences.

This is one of the problems that plagues pronghorn assemblages. After butchering and processing for meat or marrow, the bone assemblage will have started to show signs of fragmentation. One must remember that pronghorn bones are "honeycombed and ultralight" (Byers 2003a), considerably smaller than bison elements, and in general more easily fragmented. Once the long bones are fragmented and carnivores are allowed access to the discard, it would not take long for the overall number of bones to be significantly reduced. Often a bone is small enough to be simply swallowed whole, whereas the larger ones may be carried off, resulting in their removal and associated archaeological signature. This in turn results in the under-representation of pronghorn remains in the archaeological record.

Carnivores may selectively scavenge bone assemblages produced by humans, in part as a function of the quantity and types of nutrients associated with the bone. According to Brink (1997, 2001) carnivore selection of bony elements correlates strongly with grease content. Carnivores can be postulated to preferentially attack the same bones as would prehistoric hunters, for example those highest in grease content and most readily broken down. Often both humans and carnivores bypass particularly dense bony parts, such as the condyle of the distal humerus. However, "the amounts and types of nutrients associated with the bone in human produced assemblages depend on how the bone was originally processed and subsequently discarded. Human populations often expose bones to heat and flames during food processing and trash disposal activities" (Lupo 1995:288). The resulting bone assemblages contain very little in the way of nutritional residues and are less attractive to scavengers.

Given the ambiguity of criteria such as skeletal-portion profiles for identifying agents of marrow and grease extraction from bone, archaeologists need to focus their

diagnostic efforts on carnivore traces produced directly and exclusively during the consumption of nutrients in the bone. This requires a more thorough utilization of bone-modification traces such as tooth and percussion marks as well as notches. A quantitative diagnosis of tooth and percussion notches, as well as other diagnostic traces, enables faunal researchers to definitively distinguish hominid-generated assemblages of broken long bones from those produced by carnivores.

Binford (1981:222) suggests that carnivores, as taphonomic agents effecting bone frequencies, can be "manifested not only in survivorship but also in formal modifications like furrowing, chipping back, channeled breakage, cylinders of long bones, tooth puncture marks and bone scoring." Often the fragments of bone recovered from an archaeological site can, to the untrained eye, resemble those modified by either humans or carnivores.

Carnivores manipulate and sometimes fracture bones, but in uniquely different ways from humans. While holding the diaphyses in the forepaws, carnivores attack bones at the epiphyseal ends, since the compact bone is thinnest in this area and the nutritious spongy bone tissue is close to the surface. A number of variables may affect the success of a carnivore in gaining access to the interior of a given bone. Particularly important are the animal's strength, the age of its dentition, and size of its jaws in relationship to the size and hardness of the bone.

Bone-gnawing carnivores break bone by statically loading it between their upper and lower jaws; dynamic loading is not involved. However, as with dynamic loading, bone breakage via static loading involves conchoidal fracture. This is evidenced by the presence of scaliform (or feathered) negative flake scars on the thickness and medullary surface of tooth notches. Carnivore teeth produce notches on bones in a way that seems

to be mechanically similar to pressure flaking of lithic artifacts. The fact that carnivores consume notched fragments as they produce them may explain the low incidence of carnivore notches found in bone assemblages.

When large carnivores gnaw bison long bones, they seldom, if ever, successfully crush the elements to fragments between their jaws. Large long bones are gnawed first at an epiphysis, and as the cancellous tissue is consumed the bone shaft may be entirely opened up at one or both ends (Bonnichsen 1973). When carcass utilization is heavy, bones are often broken by using the teeth in a levering action to break off bone fragments. Many shaft fragments may not be consumed or gnawed, so they lack the diagnostic signs of crunching, tooth perforations or gnawing. This could result in their mistaken identification as culturally modified bone. However, except at wolf feeding stations, complete bison bone fragmentation is a rare occurrence. Adult bison bones found at dens or other sites where wolves socialize may be spirally fractured but are almost always well marked by teeth (Haynes 1983).

During gnawing by carnivores, the force of their levering, pulling and biting down sometimes creates spiraling cracks through compact tissue, a kind of incomplete fracturing that is easily seen after slight weathering of the element. First, the bone is perforated by the animal's teeth at two oppositional points of the epiphyseal end. At the same time the carnivore pulls out a segment, which terminates in a spiral fracture. Bonnichsen (1973:24) relates how "spiral fractures are initiated and radiate outward from a loading point toward the opposing epiphyseal ends and usually terminate short of the spongy bone at the ends." Because such gnawed bones usually have an epiphysis missing and are structurally weakened, they are likely to fracture when kicked or trampled by large animals, with the fracture directed partly along the spiraling crack

lines (Haynes 1982). The splinters that occur at the loading point are usually considered by archaeologists as worthless bone scraps since they generally do not retain diagnostic features that allow for speciation. However, these fragments are very important for identifying the method of bone alteration and often contain unique markings.

Haynes (1980, 1982) and Lyman (1994b) distinguished between scooping out of cancelleous bone and gnawing. However, the latter is accomplished by the same process of drawing the teeth across the bone surface. The "scooped out" appearance of thin walls of compact bone is explainable by the fact that cancellous bone is much softer and more digestible than compact bone, and thus the compact bone walls are left intact. Crunching and splintering are other kinds of bone alteration. These types of modifications are not restricted to large carnivores, but are accomplished by a number of other carnivores including smaller canids. The degree of modification that any bone undergoes is largely contingent upon the amount of shear stress that an individual animal can exert in relationship to the yield-or-failure-threshold of an individual bone. A large powerful animal such as the timber wolf can shear a small deer long bone in half between its scissors-like carnassial teeth (Garvin 1987). This shearing action will sever the bone transversely as well as splinter it longitudinally. A smaller animal such as a coyote may completely gnaw off one or both epiphyseal ends of a bone, greatly weakening the bone structurally, before it will have the strength to compress the remaining diaphysis sufficiently to bring about its collapse. Generally, such bones will collapse into longitudinal splinters, which may then undergo further alteration through the process of gnawing.

The last category of alteration is partially digested bone. Klein and Cruz-Uribe (1984) and Lyman (1994b) indicate that bones digested by carnivores have a

characteristic morphology. The surface of the digested bone may be scalloped, and take on a distinct polish. The broken edges may be relatively sharp and circular holes or surface pitting may occur in the body of the fragments.

While researching the damage carnivores can do to pronghorn elements, it became evident that very little information was available. A number of publications deal with the predation of young pronghorn fawns and aged individuals, but stop short of discussing the actual damage caused to the elements. Therefore, in order to examine example of carnivore/skeleton interaction a proxy species was needed for which the required research had been done. Fortunately, Richardson (1980) documented the destruction of a number of African faunal remains by carnivores. Many of the African antelope species (Springbok, Blesbok and Steenbok) are quite gracile and similar in size and weight (10-70 kg) to the pronghorn. As well, the jackal, feral dogs and vultures, of the African Savannah all represent suitable substitutes for the canids and raptors present on the prehistoric northern Plains.

In general, all of the African small ungulate bones had fairly uniform survival rates except ribs, carpals, tarsals, phalanges and caudal vertebrae, which were easily eaten or removed. Another notable observation is that the largest bone types, for example the crania, and smallest bones, especially caudal vertebrae, have the highest and lowest survival rates respectively. Being small and located at an extremity, the caudal vertebrae are readily eaten by all carnivores (Richardson 1980:110).

Mandibles and scapulae had exceptionally low articulation rates, and long bones, crania and ribs had the highest fragmentation rates. In addition, the remains of smaller bovid remains were far more susceptible to damage by trampling than those of larger species (Richardson 1980:109).

Richardson (1980) goes on to suggest that carnivore attrition would depend on the local availability of food. Camp dogs would be especially active as the scraps and bones from butchered carcasses most likely represented their diet base. Coyotes, wolves, and other carnivores would not be granted such access. In fact, they would be taking a risk raiding a camp for food, even if it were only being taken from the trash midden. Meanwhile, camp dogs would be expected to help themselves to discarded animal products or at least be allowed supervised access.

Camp dogs, coyotes, bears and wolves would all be capable of crushing and eating even the most robust pronghorn element (Richardson 1980:113). Those that could not be fragmented are generally small enough to swallow whole. In addition, foxes, eagles, ravens, crows and magpies would all have taken their turn scavenging faunal remains, often simply removing what they could carry off, to consume at a less hostile location.

Based on Richardson's (1980:118) research, after six months of, trampling, and scavenging by jackals only 30 % of the small ungulate elements survived and of those only 10 % remained undamaged. After six months the African antelope assemblages was no longer disturbed by carnivores, and their survival seemed to remain relatively static (Richardson 1980:119). Once this stage had been reached, only trampling, weathering, burying and removal by rodents will affect bone survival in natural situations (Richardson 1980). Therefore, it can be assumed, at least in part, that the low frequency of pronghorn elements in the archaeological record is due to scavenging activities.

5.4.2 Weathering

The environmental modification of bone is one of several natural processes by which nutrients are recycled. Behrensmeyer (1978:153) defines the weathering of bone as "the process by which the original microscopic organic and inorganic components of bone

are separated from each other and destroyed by physical and chemical agents operating on the bone *in situ*, either on the surface or within the soil zone." The severity of the weathering conditions, the length of exposure to them, and the size and density of the element all influence the speed of this process. In fact, bone that is lying on the surface is subjected to weather cycles such as freeze/thaw, hot/cold, and wet/dry, resulting in the structural breakdown and demineralization of the element. Particularly destructive are the hot, dry, windy summers of the northern Plains, which results in the severe desiccation of the bone. At sites located on the prairie proper, the extremely slow deposition of soil no doubt resulted in prolonged exposure of most faunal remains, resulting in the characteristic desiccation and splitting of the bone surfaces (Brink et al. 1985).

Research conducted by Brumley (1983:33-34) at stone circle sites within the Forty Mile Coulee area contrasted bone preservation in exposed prairie surface sites to sites on coulee slopes or coulee bottoms, where soil deposition is rapid. The prairie sites contained less than 10 % of the bone material found in similar sites in the coulees, where faunal remains are abundant (often 80 to 96 percent of a site assemblage) (Brumley 1984:106). Bones that are rapidly buried have fewer tendencies to crack than bones that are exposed to numerous weather cycles, fire, boiling or other modifying situations.

Bone left lying on the prairie surface after site abandonment quickly succumbs to the elements. General support for this statement comes from the work of Tappen and Peske (1970), who showed that exposed bone quickly develops deep weathering cracks along split lines. As the bone fractures into smaller pieces, the weathering process accelerates.

The desiccation of bone causes it to shrink differentially generating cracks and fissures along the functional orientation of the element. In regard to this study functional

orientation is defined as the "orientation of a majority of the collagen fibers of the bone matrix within an area" (Tappen and Peske 1970:383). Tappen and Peske (1970) have shown that postmortem cracks in bone, produced by the action of weather or other agencies, cause shrinkage to be oriented based on the collagen matrix of the bone. This investigation provided evidence that split-lines and weathering cracks delineate the same biological phenomena. Both "weathering cracks and laboratory-produced split-lines essentially result from the same orientation of the collagen matrix in the bone" (Tappen and Peske 1970:383). The criteria for recognizing postdepositional effects, primarily chemical leaching and demineralization or decalcification have received less attention, but include the degree of bone friability and obvious corrosion of bone surfaces by chemical attack.

Through experimentation and observation, taphonomists have been able to establish a scale of degrees of weathering and history of exposure (Reitz and Wing 1999:137). The assignment of weathering stages, which are a great help to the faunal analyst when recording weathering data, are based on the macroscopic appearance of the element, especially its surface. The criteria for recognizing and recording predepositional weathering were originally outlined by Behrensmeyer (1978) and subsequently modified by Todd et al. (1987). This includes the descriptive stages 1 (unweathered) through 6 (severely deteriorated) of bone weathering and deterioration

Surfical damage may indicate to the faunal analyst the degree of exposure of bones to physical or chemical weathering, either before or after deposition. Such weathering of bone can selectively remove less durable bones (density mediated bone destruction), tending over time to leave only the harder elements. Assemblages created via weathering

often have a composition that closely resemble ones created by carnivore gnawing or mimic the faunal assemblages produced by hunters involved in grease rendering.

Observations on naturally caused death sites in open short-grass settings on the North American Plains indicate that, given the seasonal variability in temperature, precipitation and solar radiation, some elements may take up to 50 years to reach weathering stage 6. It has been noted that bone that has escaped or survived the depredations of carnivores lasts a relatively long time. Its preservation depends on the local situation, for example unburied bones that are shielded by a favorable microclimate, provided perhaps by vegetation, are more likely to survive than are those exposed to harsher conditions.

Weathering may also produce longitudinal fractures extending from the proximal to distal end of the element. These may bend around the shaft and may be confused with fractures made by humans extracting marrow and are often referred to as "spiral fractures" (Reitz and Wing 1999:138). Weathered, spirally fractured long bones have been found in open and dry grassland, but they are more numerous in well-shaded and moist areas such as woods, parkland, and thick grass-sedge meadows or in wet areas such as pond and lake bottoms or stream crossings. Bones in the moister areas undergo a considerable reduction in the deteriorating effects of weathering and heavy trampling. This is facilitated in part by the presence of bison traffic, which aids in the bones eventually disappearing into the viscus soil due to continued trampling (Haynes 1983:111).

In summary, pronghorn faunal assemblages, particularly the long bones, would have been extremely susceptible to the destructive forces of weathering. This is based on the assumption that the majority of northern Plains pronghorn would have been killed within

their preferred habitat, the prairie ecozone and pronghorn elements left at the kill sites would have experienced more accelerated weathering than elements transported back to a campsite located on a river terrace. This fact might offer a partial explanation for the apparent lack of pronghorn kill sites, based on the reduced survivorship of the bones, due to weathering.

5.4.3 Trampling

Damage from trampling is important to recognize as it reflects the depositional history of the site and the bone modifications it produces may be confused with butchering marks. Trampling moves specimens from their depositional context, fragments them, and produces marks on surviving specimens (Shipman and Rose 1983). In fact, it is this trampling of exposed and degraded bone by prehistoric and historic ungulates as well as human populations during use and reuse of sites that makes the understanding of this process so critical for archeological interpretation.

A number of papers have been published on bone modifications produced as a result of trampling by humans and ungulates (Haynes 1991; Olsen and Shipman 1988; Yellen 1991). The research to further the understanding of trampling as a taphonomic process may be divided into four major categories: 1) The examination of bone from palaeontological and archaeological sites where conditions suggest that trampling was a significant cause of damage. 2) The observation of bones altered as a result of trampling by indigenous people or herds of animals. 3) Experimental replication of trampling of bones by humans or herds of animals. 4) The collection of modern bones from the ground surface where conditions suggest that trampling was a major source of damage, but where actual observation of the activity is absent.

All of these methods have certain intrinsic disadvantages and limitations, which must be recognized in order to validate interpretations of bone modification as trampling marks (Olsen and Shipman 1988). Having said this, it is necessary to establish criteria for segregating trampling from culturally inflicted cut marks, and if possible, from other taphonomic processes which move, break, abrade and otherwise modify bone.

Trampling by hoofed animals includes both inadvertent kicking and placement of the hoof directly upon an object on the surface of the ground. Kicked bones when moved several centimetres or more can undergo impact, however, this is apparently of insufficient force to cause fracturing when the element is whole or fresh (Haynes 1983). Trampling bison herds can also move articulated carcass remains many metres from the original places of deposition, however, according to Haynes (1983) fractures are not produced this way unless the bone is fresh or carnivores have gnawed off an epiphysis. In addition, weathered and degreased limb bones, being much more brittle than fresh elements, often fracture when kicked or stepped on by large animals. Archaeological evidence for this form of physical rather than chemical bone destruction is cited by Fisher and Frison (2000:93) as one of the taphonomic agents that played a role in the formation of the Boar's Tusk site (48SW1373) pronghorn assemblage.

Haynes (1983:111) states that "The most common destructive effects of trampling seen on bison ranges are splintering and crushing of ribs, vertebrae and scapulae. Nasal bones and premaxillary bones may be kicked off skulls, and teeth are broken out of sockets. Mandibles may be segmented into ascending ramus, the central cheek toothrow minus lower border, and the forward part of the ramus. Pelves may be broken in half or into several fragments, with the bone surrounding the acetabulum surviving the longest. Many elements are reduced to fragments and unidentifiable splinters." In addition,

trampling may result in incomplete spiral fracturing of many weathered long bones that are within stages 1 and 2 of Behrensmeyer's (1978) descriptive framework. Bones in this category possess sharp-edged longitudinal drying cracks, little or no soft tissue, and only minor peeling of periosteal tissue on bone.

This knowledge is important for the archaeologist as "ungulate trampling reasonably accounts for long bone spiral fracturing and therefore human agency in bone fracturing is not necessarily demonstrated by the simple existence of spiral breaks" (Haynes 1983:102). In fact, a dense series of usually superficial parallel striations across a broad area of bone may be either scrapemarks, resulting from trampling or cultural periosteum removal. In addition to the trampling damage mentioned above, several other alterations to bone assemblages might be the result of this taphonomic process. According to Klein and Cruz-Uribe (1984) surface polishing accompanied by edge rounding may result when weathered bones lie in a body of sand regularly disturbed by trampling. Also, post-depositional trampling or profile compaction may mimic or obscure breakage or flaking caused either by humans or carnivores.

5.5 Cultural Processes Affecting Bone Survivorship

5.5.1 Introduction to Carcass Utilization

The presence of variation in skeletal element representation in archaeological assemblages has long been recognized as resulting in part from human activities, including the kill, butchering, and transport of meat and hides as well as food processing and waste disposal. These have been interpreted by applying either differences in bone density and resistance to attrition (Grayson 1989; Lyman 1984), or patterns in element selection for transport from kill sites to camp sites, or a combination of the two.

Therefore, the interpretation of a wide variety of smaller kills is of major importance in reconstructing the full spectrum of prehistoric subsistence strategies on the northern Plains. "Paradoxically, most of the methods of faunal analysis traditionally used by Plains researchers require very large samples from bone assemblages produced by a single event" (Landals 1990:123).

At small-scale kills the hunter has to make an initial decision, based on assessments of transport constraints, whether to transport the entire carcass or to subdivide it and abandon some parts or skeletal elements (presumably those of lowest utility). The decisions may be characterized as Maximum and Limited Carcass Recovery strategies, respectively (Emerson 1993:145). Depending upon which strategy is chosen, the composition of the assemblage transported to base camp varies considerably. When a Maximum Carcass Recovery strategy is employed, the entire carcass is selected for return, and parts are subsequently eliminated from the assemblage, on an as needed basis, to meet food needs enroute to the campsite. With repeated use of this strategy, axial units should dominate the assemblage of all parts returned to campsites. This is based on the fact that these are not the parts that are selected for food away from the camp (Emerson 1993). The alternative, Limited Carcass Recovery strategy, is one in which total recovery is not possible and subsets of the carcass are selected for transportation or immediate discard. The pronghorn data collected from EbPi-75 and DlOu-72 (see Chapter 6) appear to be representative of the variability possible in a Maximum Carcass Recovery assemblage composition.

Regardless of which carcass recovery strategy is used, the assemblage of bones that arrives at the campsite frequently differs from that initially selected. At the kill site, body parts may be left unused because they are tainted. Other body parts may be

selected for consumption at the kill site or at intermediate snacking locations on the way back to the campsite (Bunn et al. 1988). Those units selected for use and discard, in contrast to those abandoned because of unacceptable quality should be controlled by assessments of processing and transportation costs.

Additional post-discard processes also have a significant effect on the faunal assemblage that is recovered by the archaeologist. These include carnivore attrition, trampling, and weathering, which may eliminate less durable skeletal elements from a faunal assemblage. In addition, the degree of utilization (marrow and grease extraction) will have an influence on the composition of the assemblages. Highly comminuted elements are representative of bone marrow extraction and this activity is seen archaeologically in a high degree of spirally fractured bone fragments. Furthermore, if elements are being further reduced to make bone tools, such as those found at the Gowen I site (Walker 1992) and Sjovold site (Dyck and Morlan 1995), then additional modification of the faunal assemblage will occur.

Clearly, major changes to assemblages often occur after their arrival at the campsite and must be accounted for in order to accurately interpret the archaeological record (Emerson 1993)

5.5.2 Primary/Field Butchering

Field processing or butchering is defined as the act of dividing a resource "package" into its constituent components at or near its place of procurement with the goal of transporting only selected, comparatively high-utility components for use elsewhere (Metcalfe and Barlow 1992:341). This definition is consistent with the traditional archaeological interest in behavioural decisions that structure prehistoric assemblage composition. Specifically, it emphasizes the relationship between field processing and

transport and its inherent trade-off. Other types of processing in the field certainly can and do occur: for instance, resources may come in packages too large to transport as a unit. These field processing and transportation decisions are of particular importance to archaeologists interested in predicting the probable effects of differential transport of resources on assemblage composition.

Resources are generally procured as "packages" consisting of the sum of the parts. In general, when processing for consumption the process will be reductive. An interesting implication of this is that when travel times are sufficiently large for these resources, processing for transport might be more extensive (Metcalfe and Barlow 1992).

The decision whether to field process before transport is only relevant when certain conditions are met; some of which are the function of other decisions. Accordingly, it is assumed that the hunter's residence and the resource in question are not in the same location, that the resource can be profitably exploited given the distance involved, and that the hunter has decided to procure the resource with the goal of returning it home for consumption. The basic premise is that hunters will make field-processing and transportation decisions in an economically efficient manner (Metcalfe and Barlow 1992:344).

Various studies (Bunn et al. 1988; O'Connell et al. 1988, 1990) have demonstrated that hunter-gatherers can be very selective about which animal body parts are transported from kill sites to residential camps and the transport distance is an important variable in determining how many bones are transported (O'Connell et al.1990). Although transport distance has long been argued to be an important conditioning variable in determining how many bones are transported, the Hadza research is the first quantitative demonstration of its significance (Metcalfe and Barlow 1992:341).

Butchering is essentially the cultural act of separating or segmenting an animal carcass into its many parts. The methods for doing this are varied, with each culture having its own distinct archeological signature. It is these signatures, often in the form of surface markings or uniquely shaped bone fragments that the archaeologist uses to investigate the cultural processes of utilization with regard to faunal resources on the Plains. As butchering encompasses the decision-making processes of carcass reduction, it provides the researcher a glimpse of the subsistence patterns of the Plains hunter-gatherer. In fact, it is these subsistence choices that contribute to the unique archaeological composition of each faunal assemblage.

Numerous examples exist in the ethnographic and archeological literature with regard to the Plains diet and associated butchering practices. These include descriptions of the process of stripping meat from the bones and dismemberment via bone chopping, as well as drying or smoking meat to preserve it, transporting the meat and the marrow bones separately, and scavenging natural and previously processed bones for marrow in times of nutritional stress. Early work on to the various processes involved in formation of faunal assemblages was undertaken by White (1952, 1953a, 1954, 1955) with Madrigal and Holt (2002) providing some of the more recent insights into the various processes of butchering.

When processing an animal for utilization there are two stages, primary and secondary butchering that a carcass must undergo. With regard to primary butchering it is generally divided into two subtasks, light and heavy butchering. This distinction between light and heavy butchering (Gilbert 1969) is also readily discernable. Light butchering probably would be carried out at a greater distance from the living area; most of the bones and unusable portions of the carcass would be left behind at the butchering

site itself, which would then probably contain a higher proportion of crania and vertebrae as well as lower limbs. The campsite would contain more upper limbs and sometimes ribs. Variations may occur depending on delicacies and cultural preferences as well as on the distance from the campsite. Heavy butchering would be expected to occur in or near the camp, which might be either permanent or seasonal-nomadic. Almost all the bones would be represented, often in refuse heaps as in the Oyster Ridge site (Zier 1982). Brink et al. (1985) observed that processing areas, in contrast to kill sites, contained much the same faunal data, however, they were in a "ravaged" form. By definition these areas are characterized by the reduction of bison carcasses to useable, storable foods. The meat, fat, organs, hides, bone and horn are converted into preserved supplies and items of utility.

While primary butchering on the Plains generally occurred at the kill site this depended upon the animal's size and distance from the campsite. Initial butchering included evisceration, removal of the head and partial cutting up of the animal. With regard to larger animals the meat was probably stripped from the backbone, ribs and skull. In addition the hind and fore quarters were also removed. Finally, all of these butchering units were placed in the hide for transportation to the processing area or campsite. Here secondary butchering began. This involved removing the metapodials and phalanges by smashing through the mid-shaft of the metacarpals and metatarsals. Metapodials and phalanges are the most common element at secondary processing sites. Next some meat was stripped from the quarters and set aside to be cooked or made into pemmican.

A few butchering units containing the hip and shoulder bones were removed to be cooked as a unit. The long bones and metapodials were smashed in order to remove the

bone marrow. Bone grease extraction often did not occur at the secondary-processing site but took place at another task specific location.

If there are fewer distal phalanges than proximal and medial phalanges present then it is quite possible that they may have been used for making glue. Davis and Fisher (1990) note that the presence of multiple phalanges [like those recovered at Lost Terrace] may be indicative of simple discard of the foot elements intact or, alternatively, discard of the individual elements following boiling for glue extraction. In addition, the horns, hooves and hide were often used in the making of glue (Brumley 1978).

Even when communal hunting is the selected method for the procurement of large numbers of pronghorn, processing is carried out not at the kill site, but either at an isolated processing site or at the campsite.

Skeletal remains of pronghorn in and around the pronghorn traps are scarce, leading me to believe that once the animals were killed they were carried away to be butchered and processed at nearby campsites. The Laidlaw site (Brumley 1983, 1984) serves as a good example of this process.

If left intact the carcasses would be no harder to carry than a large sack of grain, however if dismembered, several trips, or more than one individual would be needed to remove the entire animal from the kill site. Supporting evidence for this comes from Denig (1961:529) who states that "An ordinary Indian cannot lift more than 125 to 150 pounds at most yet most of them will carry a large deer on their backs, traveling at a swift pace for miles without stopping and this is equal to 170 to 185 pounds weight.... The greatest burden we have known an Indian to carry any distance, say 3 or 4 miles, was two entire antelope, about 225 pounds."

Crader (1983:108) notes that in Africa "smaller animals such as impala..., are brought back to the village as complete carcasses." Along the same line of evidence Frison (2004:114) notes that "One person can quickly field dress and transport an animal the size of an average deer, pronghorn, or mountain sheep, but not a bison, which must be cut into pieces small enough to handle effectively."

Due to the size of the pronghorn, entire carcasses could quite easily have been brought back to the campsite for processing and consumption, rather than selected butchering units. In fact, there is a strong case to be made that pronghorn, due to their size and weight, were not dismembered at the kill site and transported back to either a processing site or campsite, as was the case for bison or caribou. Instead, pronghorn, as discussed later in this chapter, were most likely field dressed at the kill site and transported back to the campsite, more or less intact. This being the case, elements of the pronghorn skeleton would be subjected to the density mediated destruction caused by intensive processing as well as the naturally occurring pre- and post-depositional processes at a single location, the campsite.

The importance of this initial field dressing is clear in the following quote. "These animals [pronghorn] spoil very quickly if not disemboweled" (Dodge 1959:356). Surely this fact was not lost to the aboriginal hunter, however, the location of the kill/field dressing site may be lost to archaeologists due to its ephemeral nature and the impact of pre- and post-depositional processes. These sites might have consisted of little more than several projectile points, a few lithic tools and debitage, and perhaps an unprepared hearth. All of this would have taken place in the hostile environment, as far as organic remains are concerned, of the northern Plains prairie ecozone.

5.5.3 Transport of Carcass Parts

As stated above, carcass transport is an important factor in the formation of a faunal assemblage. However, since many other factors also contribute to assemblage formation, it is often difficult to unambiguously identify transport-related patterns. Archaeologically, carcass transportation choices made by the hunter can be seen in the makeup of the elements represented in the faunal assemblage. White (1953a:396-397) noted, "with large animals like the bison, most of the metapodials, pelves, vertebrae and skulls are left at the kill, while deer and antelope were probably brought back to the village for butchering." In accordance with models where killed animals are transported short distances cranial elements, metatarsals and metacarpals are abundant at the campsite.

Perkins and Daly (1968) later renamed this postulated phenomenon the *schlepp effect*, from the german verb *schleppen*, to drag. The effect is well documented ethnographically by Binford (1978, 1981).

Binford (1978) has suggested that bone transport by humans is largely "contingency bound." That is, transport and caching (and butchering) of particular anatomical segments or butchering units is determined by such variables as the number of animals killed, the season of the year, the food situation at base camp, the number of people at the kill and base camp and the distance of the kill from base camp. Human transport of edible portions and bones from the kill site is determined by a series of decisions regarding how the food can most optimally be utilized given past, present, and predicted future conditions affecting subsistence levels. Binford (1978) attempted to quantify this through the development of the "Modified General Utility Index" (MGUI). The MGUI

can therefore be considered as a proxy measure of the potential for cultural bone transportation.

In the case of the pronghorn weight is the largest determining factor for what gets transported from the kill site to the camp site. Within a reasonable distance a single individual can carry a field dressed pronghorn carcass back to base camp. However, outside of this optimal distance such factors as the amount and value of meat, grease and marrow associated with particular elements begins to play a role in transportation decisions.

In addition, archaeologically it is difficult to isolate kill conditions such as season and distance of the kill site in a midden. The assemblage resulting from the transportation of animals from various kill sites under different conditions can at best produce a generalized picture of procurement. Elucidating the conditions surrounding carcass recovery is difficult due to the uncertain treatment those elements receive after transport to the campsite.

5.5.4 Secondary Processing

5.5.4.1 Fresh and Dried Meat

Following a successful kill, the animal would first have been skinned and butchered. Most of the meat would be removed from the bones to be distributed, eaten, or preserved, thereby disappearing from the archaeological record. The amount of meat available from the pronghorn killed during a hunting episode depends not only on the number of animals killed but also on their age and sex as well. Mitchell (1971, 1980) and Field et al. (1972, 2004) have presented dressed carcass weights for Alberta and Wyoming pronghorn by age and sex. It must be remembered that carcass weights represent only the amount of meat available, not the actual amount used.

Some bones were saved and used to make tools or other artifacts, but most were discarded once the meat and other nutrients are removed. The vertebrae and ribs have high meat yields, but they contain no marrow, are not particularly useful for tool manufacture, and have a low structural density. If not processed for their bone grease, vertebrae and ribs would be discarded immediately, perhaps by dumping them at the site's periphery or in secondary disposal areas where they might be further altered by scavenging dogs or other carnivores.

Bones with low marrow yields were fractured by humans less often than high-yield marrow bones. Whether the low-yield marrow bones from any given carcass would be exploited for their marrow is presumably related to the relative need for marrow fat and the availability of other foods. Unfractured low-yield bones, since they would retain marrow grease, would remain attractive to scavenging carnivores. Unbroken low-yield bones, therefore, are more likely to be completely destroyed or removed from the site by scavengers than high-yield bones. Bones with high marrow yields are most likely to be fractured by humans to remove the marrow. The epiphyseal fragments may be rendered unidentifiable by additional fragmentation for grease processing. If not processed to remove bone grease, epiphyseal fragments retain some nutritional value and may be completely destroyed or removed from the site by dogs or other scavenging carnivores. In contrast, heavily processed long-bone shaft fragments are not attractive to carnivores, hence are more likely to survive in the archaeological record. The end results, in archaeological terms, will be a faunal assemblage with a greater proportion of high-yield marrow bone fragments than low yield ones.

All of this information is helpful in establishing whether or not a bone assemblage is in fact culturally constructed. Owing to the fact that disarticulation on its own is not

necessarily a human process, the first step in any faunal interpretation would be to establish that the agent of dismemberment was in fact cultural and not naturally caused. "The manner in which people have dismembered carcasses of animals is an aspect of human behavior, and relevant information may be gained from the study of partially articulated skeletal material" (Hill 1979:739). If a bone assemblage may have been 'assembled' by a number of collectors including people and one or more other bone-collecting species, the common problem is to determine how much of the faunal assemblage can truly be considered cultural (Klein and Cruz-Uribe 1984:6). A promising approach is to differentiate the marks made by stone or metal tools on bone surfaces from the ones made by carnivore teeth, rodent teeth or other agents. Some archaeologists, such as Binford (1978, 1981) and Bunn (1981), feel that different kinds of marks may be reliably distinguished macroscopically whereas others, such as Shipman and Rose (1983), emphasize the need for microscopic examination. However faunal assemblages are examined one thing is for certain, butchering patterns are a product of species size and anatomy. Unlike carnivores, humans disperse bones largely on the basis of anatomical considerations relating to the food value of soft tissues (Lyman 1984:283). However, in archaeological sites, "disarticulation [often appears to be] extremely uniform in different large herbivore species, whatever the agent of dismemberment, human or non-human. This stresses the need for caution in claiming that any particular pattern is uniquely distinctive of human activity" (Hill and Behrensmeyer 1985:144).

Human butchering patterns are very similar to what happens naturally, so it is to be expected that the natural weaknesses of joints would be exploited in dismembering a carcass. The neck region offers a considerable amount of meat, and it would be sensible

to remove it with the head at some stage in the dismemberment of the carcass. For the rest of the animal it is perhaps not surprising especially considering the large size of most ungulates, that the natural weaknesses of different joints were exploited, resulting in a pattern remarkably similar to that found in an anatomically similar animal in natural circumstances. This is especially true if there is little damage to the bones themselves, which is often the case. It was most likely the practice to dismember the carcass at its joints and to remove meat from around the bones of the larger units. Therefore, disarticulation of a skeleton is no doubt largely a function of the soft tissue anatomy associated with particular joints and elements (Binford 1978, 1981; Hill 1979).

Archaeologists see examples of this whenever cut marks are encountered. Often a bison astragalus will have a series of shallow, parallel, V-shaped markings on it. These markings are evidence of an encircling cut to remove the hide from the hind leg, whereas cut marks along the spineous process of the thoracic vertebrae most likely resulted from the removal of the back muscles, longissimus dorsi and spinalis dorsi (Gilbert 1969:289).

Other skeletal evidence for butchering may consist of light cut marks below the proximal end of the humerus, on the posterior and anterior surfaces of the distal humerus shaft, and on the olecranon of the ulna. Treatment of the forelimbs this way may provide evidence for meat stripping, which was accomplished by severing muscles at insertion points. If the radii and ulnae diaphyses were smashed just distal to the interosseous space, obtaining marrow was probably not the intent but rather to severing the tendons of the distal forelimb, so as to allow easier meat stripping (Driver 1982:269). Bone breaking activities generally pertain to larger animals since the bones of smaller animals would often be discarded unbroken. This may be due to the much small quantities of

marrow present in these elements making it uneconomical to process them. Where meat removal is accomplished by bone breakage, the breaks are generally short. Whether meat is stripped from the bone or is removed by severance of the bone, the associated cuts and breaks are usually localized at muscle origin and insertion points, or in regions where muscle masses terminate even if their tendons do not attach locally (Kooyman 1981:27).

According to Kooyman (1981), it is unlikely that bone breakage patterns generally reflect initial dismemberment in Plains context especially if the strategy was to "joint" the animal, at least in terms of the appendicular skeleton, as is suggested by historic accounts (Wheat 1972:98-100). This technique is corroborated by Binford's (1978) study among the Nunamiut, although he did find that bones were smashed through if jointing was rendered impossible by freezing of the meat. However, initial butchering is almost certainly discernable in the case of the axial skeleton (Wheat 1972:99-100). Since it is probable that most meat on the Plains was dried to preserve it, later stages of butchering are unlikely to be visible in breakage patterns as the meat was generally stripped from the bones prior to final processing (Binford 1978:96-97; Mandelbaum 2001:58).

Concerning butchering marks on bone, Binford states that in his experience "...most such marks were produced not in the context of butchering, per se, but instead during marrow processing." (Binford 1978:480). This said, concentrations of heavy flake and/or knife marks, or light chopper/axe marks that do not cause breaks, would almost certainly relate to cutting/segmentation strategies or removal of large muscle masses. Since it would require more than one cut to complete either of these tasks, groups of cuts are most likely to be present at these positions. In cases where the bones were actually

broken in the butchering process, it is logical to assume that a blow was struck in a particular spot to cause severance at that location and not elsewhere. Therefore, it is probable that blows would be struck so as to minimize long spiral fracture patterns, which would cause breakage at distant locations. Breaks specifically resulting from butchering would be generally characterized by straight, short curved or spiral fracture margin morphology. Many fractured bones possess a spiral fracture edge offset by a linear section of fracture edge, thus exhibiting attributes of two kinds of breakage.

Noe-Nygaard (1977:230) found that when long bones still enclosed in their meat and sinew were struck with a stone tool to cause severance, it was difficult to predict where the fracture would occur. Absolute control of break position was not truly possible prior to the use of saws (Binford 1978:154-155). Sadek-Kooros (1972:371) states that the only manner in which long shaft fractures could be induced was by prior preparation of the shaft by a series of controlled blows. It has also been demonstrated that fractures in bone follow lines of least resistance, that notching of bone reduces its ability to absorb energy and therefore caused earlier failure and that pre-existing split lines changed the pattern of flaking in bone (Kooyman 1981:15). These four lines of evidence suggest that the optimal manner in which to produce a short fracture at a specified point would be by a single, hard blow. This minimizes the establishment of lines of weakness along features that allow for the radial release of stress. Since bone is weaker in tension than in compression (Bonnichsen 1973), conditions would be maximized to initiate a fracture opposite the break already formed by the edge of the tool. A total break would then be more likely to occur near the impact point, although fracturing due to failure in tensile strength could occur in distant areas were cortical bone was thin. Noe-Nygaard (1977:230), found that when the bone element was struck against a hard, anvil-like

object, thus initiating a much greater force due to the increased momentum, the location of the break and type of fracture were more easily predicted. Butchering breaks should be distinguished by single blow-initiated characteristics which produce localized fractures.

Also to be considered is that prehistoric peoples were undoubtedly utilizing as much of the kill as possible, including internal parts such as heart, liver, kidneys, brains, intestines and the small amount of meat on the skull. This would add at least another 10 pounds of meat per animal. Added to this would be another two pounds, approximately, of bone fat and marrow per animal. A large quantity of meat was probably dried, possibly made into some form of pemmican, and then stored in hide containers for use during the winter.

Frison (1971b) also suggests that 212 animals would provide food for 75 adults and children for about a month. Benson (2004) comments that each pronghorn male yields about 19.8 kg (44 lbs) of packaged meat, with bone left in leg, loin, rib and shoulder cuts. In addition, he (2004) states that from a field dressed weight of 31 kg (69 lbs), a female pronghorn provides approximately 14.5 kg (32 lbs) of packaged cuts without bones. These figures represent 47 % of the field dressed weight. Benson (2004:3) calculates that the head of a male pronghorn weighs 3 kg (7 lbs) and the skin weighs 2.7 kg or 6 lbs.

In general, Marchello and Garden-Robinson (2003) agree with these figures, claiming a 43 kg (96 lb) whole body weight (weight of entire animal minus blood lost during harvest), a 33 kg (74 lb) field dressed weight (whole body weight minus entrails), and a carcass weight (field dressed weight minus head, legs and hide) of 27 kg (60 lbs). Using Wyoming Game and Fish Commission Research Laboratory figures Field et al.

(2004:2) calculated the average field-dressed weight of a male pronghorn to range from 29.3 to 38.7 kg (65-86 lb) and female pronghorn to range from 28.8 to 32.4 kg (64-72 lb). "Mean field-dressed weights of 320 mature males and 191 mature female antelope shot in Alberta, Canada were 85.0 pounds and 76.6 pounds, respectively" (Field et al. 2004:2).

According to Blumenschine and Caro (1986:273) there is "relative consistency in the percentage of whole carcass flesh (about 50%), however, there exists differences in the distribution between sexes, however, apparently not among age classes." Flesh yields are also known to vary with carcass fat levels and will certainly be affected by the relative fullness of the digestive tract upon death. This relative flesh to bone weight might also condition the skeletal profiles of archaeological assemblages. Here, parts with the highest flesh to bone weights might be taken consistently from procurement locations to consumption locations intact, and therefore be well represented skeletally at 'living' or 'camp' sites. The cost of transporting whole parts bearing relatively little flesh compared to bone, may be sufficiently high to warrant defleshing at the point of procurement, and the abandonment of the bones there. Within any single carcass unit, age, sex and taxonomic differences in flesh to bone weight ratios would potentially modify these processing and transport decisions.

The demonstrated variability in unit flesh yields presented above has implications for the applicability of Binford's (1978) flesh yield data to archaeological fauna. If the relative nutritional utility of carcass units is to accurately reflect processing and transportation decisions, this variability needs to be taken into account. For example the pelvis-lumbar region of female bison yields more flesh than the hindlimb, and might be preferentially exploited and represented in archaeological assemblages. Such selection,

however, would be reversed for adult male bison. Similarly, the neck will hold a variable flesh yield relative to the forelimb as a whole, depending on the sex being considered. The ranking of carcass parts according to flesh yields will also be species specific.

Unfortunately, the activities associated with the preservation of foodstuffs are not always manifested in the archaeological record. Meat stripping and drying were no doubt an integral means of preserving food, yet there is very little obvious archaeological evidence of this important activity. However, all is not lost as ethnographic evidence on the topic of meat drying is prevalent and in this case must be substituted for artifactual confirmation. One of the most complete examples of meat drying is provided by Ray (1984) and is set within the context of provisioning a Plains trading outpost.

The meat, when taken to the hunter's camp, was cut up by the women into long strips about a ½ cm thick. The strips are hung upon a lattice-work of willow bows to dry. This lattice-work was formed of small bows interlaced and supported by wooden uprights. In a few days the meat was thoroughly desiccated, bent and broken into equal lengths, and tied into bundles of 27-32 kg (60-70 lbs) weight for transport. The final product was called dried meat. Further along, Ray (1984) again describes a method for meat drying "drying meat involved cutting it into long strips about 0.6 cm (0.25 inches) thick. The strips were then hung on wooden slats supported by tripods of sticks. It took two or three days for the meat to dry. The better quality dried meat was packed into bundles. The remainder was dried further over a hot fire until brittle" (Ray 1984:265). This meat was destined to become pemmican. This additional step is due to the fact that "Dried raw meat on its own is insufficient to sustain a healthy balance of protein and carbohydrate intake" (Brink et al. 1986:249).

Another ethnographic example, this time by Mandelbaum (2001) addresses the processing of meat by the Plains Cree. The first care of the women when meat was brought into camp was to dry it properly. A block of meat was cut spirally into thin sheets which were hung up to dry. In summer, a drying rack made of two tripods joined by a number of horizontal poles was set outside of every tipi. During inclement weather a drying rack consisting of four uprights that supported a platform was erected over the fire inside the tipi. When strips of meat were thoroughly dry, they were tied in small bales or stuffed into rawhide sacks. Finally, Kehoe (1967) provides a Blackfoot example of how fat was integrated with dried meat to form a more stable food product. "The roast (man'o) was separated from the sinew in it by slicing it along the sinew and pulling it apart. The meat was excellent for drying and putting it up to dry involved slicing it in strips not quite cut through (apart) until after it was removed from the drying rack. The back fat (osak') was sliced off in long strips. Back fat is the same fat that runs about one inch thick along rib steaks. Back fat was added to pemmican, as bacon fat might be added as fat" (Kehoe 1967:70).

5.5.4.2 Bone Marrow

Bone marrow and bone grease represent two forms of fat that, in addition to carcass fats, are important parts of the total fat composition of large mammals. The distinction between these two fats have been well documented in the animal science literature and is of interest primarily to archaeologists.

Bone marrow generally refers to the fatty acids found inside the medullary cavities of the bones of most animals. According to (Madrigal and Holt 2002:748) "marrow is composed of fat, water and a small, constant amount of non-fat cell residue." During the entire span of prehistory marrow was most likely viewed as a very valuable dietary

resource. Initially, among early hominids, this may have been due to the fact that marrow is protected by bone and is more likely to survive the initial feeding process of carnivores. Later, it would have been valued for its nutritional value and possibly for its taste. Marrow extraction typically involves the breaking of long bones and removal of the marrow from the medullary cavity. Marrow could have been eaten on the spot or may have been incorporated with the bone grease and used when making pemmican.

Marrow is typically recovered as a cohesive mass after exposing the marrow cavity. Brink (2001) states that bone marrow and grease represent two forms of fat that, in addition to carcass fats, are important parts of the total fat composition of large animals. This is especially true with regard to bison because of the large size of the bones. The distinctions between these two bone fats, grease and marrow, has not been documented in the animal science literature but are of interest primarily to archaeologists.

The fats contained within grease and marrow represent the richest source of fat available from a carcass. That is, the true chemical fat content of marrow, as opposed to non-fat components such as ash, protein and water, is substantially higher than it is in carcass fat tissue. "In healthy adult animals the chemical fat in marrow is frequently over 90 %, although this is seen to vary with seasons. In contrast, carcass fat tissue is composed, on average, of about 70 % chemical fat in healthy adults, and considerably less in animals under stress. In addition, the specific fatty acids that comprise marrow and grease tend to be dominated by the more unsaturated fatty acids, especially oleic acid" (Binford 1978:23-24). Ruminants are known for being generally high in saturated fatty acids and low in unsaturated fatty acids relative to other large mammals. If Binford (1978) is correct in asserting that the soft, unsaturated fatty acids were more desired by hunters, then repositories containing predominately these acids may have been highly

prized despite the fact that the absolute weight of fat is minor compared to that of other carcass fats. Certainly there is evidence in the historic literature that marrow was a favourite item of the carcass among recent bison hunters (Wheat 1972). Finally, the two bone fats are the most stable of all the carcass fats and will be present in animals that are otherwise fat depleted. This may be of profound significance in hunting and gathering cultures at times of great nutritional stress.

"The primary food value of marrow lies in its rich content of phosphoric acid, in combination with other substances, constitute the phospholipids. These are important for the transformation of energy" (Vehik 1977:172). A good source of phospholipids can be found within some of the bones of medium to large ungulates, such as bison, elk, deer and pronghorn. These are the major animals involved in bone marrow processing on the Plains, since the bones of smaller animals are generally discarded unbroken. Some of the bones of the larger animals that are broken to obtain marrow include the humerus, radius-ulna, metacarpals, femur, tibia, metatarsals, body of the mandible and the vertebral canal (Zierhut 1967).

It is worth discussing here that although phalanges are known to have a very low kilocalorie yield they may, in fact, have been utilized during times of nutritional stress for marrow extraction. Binford reported that "phalanx marrow was not extracted by the Nunamuit, and that the Nunamuit stated that it was only used during food shortages" (Binford 1978:31). This is understandable given the low marrow yield and increased effort needed to extract marrow. Although the net yield of phalanx narrow is undoubtedly lower than that of long bones, it may be higher than that of other, non-animal foods, therefore making its use feasible. Because phalanges are the most distal limb elements, the marrow they contain is the last to be mobilized by nutritionally

stressed animals. Therefore, as animals become increasingly nutritionally stressed, such as during the winter, the marrow in phalanges may constitute a greater relative proportion of the available energy from a single animal (Madrigal and Capaldo 1999). Speth (1983) also suggests that the presence of phalanges and mandibles at bison kill sites may indicate the presence and degree of food insecurity: "Both elements produce edible marrow and hence are potential food sources, but phalanges require considerable labor to extract useful quantities of marrow ... Phalanges are problematic ... because they often are found at processing sites and campsites with no evidence of having been broken open for marrow. They probably were commonly removed from kill sites as riders attached to more desirable limb units" (Speth 1983:167). A notable exception to this is the Gowen I site were numerous phalanges were removed during butchering and left behind (Walker 1992).

The dominance of phalanges in and around archaeological features, the frequency of metapodial fragments, and the lack of bones such as femora and humeri that rank higher with regard to fat weight may indicate grease production during late winter or early spring. By then the bison would have been depleted of fat reserves in other body elements, and caches of upper appendicular bones may have been exhausted. Thus, food insecurity would have forced inhabitants to scavenge and process bones they otherwise might have ignored.

Zierhut (1967) and Bonnichsen (1973), in order to substantiate the above work and render it applicable to archaeology, then conducted further research. During the examination of the 82 collected fragments that were almost certain to have been the result of marrow extraction, 50 (61%) showed long spiral fractures (6 cm or more in length), 18 (22%) showed short spiral fractures (5.5 cm or less in length) and all other

fracture margin patterns totaled 14 (17%). When individual bones were pieced back together and the total marrow cavity measured, 40 (74%) of the 54 elements had 5 cm or more of the cavity exposed and only 14 (26%) had less than 5 cm exposed. This substantiates the proposition that marrow processing tends to expose the cavity by the use of techniques that result in long spiral fracture patterns.

The extraction of marrow plugs from the major limb bones requires few, if any, tools especially if the marrow is consumed raw. The archaeological signature of such an activity would include the articular ends of the bone, which should exhibit impact fractures and fresh (green) bone fractures. To substantiate this, Reeves (1990) related how depression fractures are associated with intentional spiral-bone breakage, which is attributed to marrow extraction.

In agreement, Kooyman (1981:17) states that "Marrow extraction should result in generally long spiral fractures to maximize exposure of the marrow cavity and hence facilitate marrow removal. These breaks should also typically show multiple blows along the long axis of the bone to initiate this type of fracture." However, these features must be regarded as tendencies only, as this form of break is not absolutely necessary for marrow extraction, it only makes the operation easier. This said, Kooyman (1981:216) continues by asserting that "longitudinal splitting of elements and the initiation of long spiral fractures both appear to be indicative of marrow extraction." Also, "a high incidence of breaking blows within the unidentifiable fragments is a possible indicator of element fragmentation for marrow extraction" (Kooyman 1981:218). Recently, Kooyman (2004:204) stated that "fracturing bones to extract marrow results in the production of a much higher frequency of long spiral fractures on the bone fragments than would be expected in non-cultural breakage."

The calculation of archaeologically preferred bones for marrow extraction is much more complex than those for bone degreasing. Although simple element presence or absence can be used to argue for grease rendering, marrow extraction can only be inferred from green (fresh) bone breaks found on the shafts of long bones. These breaks also may result from carnivore activity or trampling (Morlan 1983:252). In addition, various taphonomic processes can obscure the broken ends of many limb elements. Although it may be difficult to tell whether these breaks were the result of intentional marrow extraction or other agencies such as carnivore activity, it is possible. Recently Kooyman (2004:205) stated that "Long bone spiral fracture frequencies of about 25-35 percent or more for a particular element are indicative of marrow processing." A final confounding variable is that the activity of bone degreasing can totally destroy any evidence that an element was originally broken to remove the contents of the medullary cavity.

A further problematic aspect results in the fact that marrow was often not processed separately from bone grease, especially if the bones were broken up and boiled and both grease and marrow were skimmed off the water at the same time. Part of the problem of interpretation may stem from the fact that the terms "marrow" and "bone grease" are often used interchangeably. Based on ethnographic evidence such as Binford (1978) these two activities were treated as unique processing activities and therefore were temporally segregated.

In fact, given the nutritional content and preferred food status of marrow, it is likely that cracking of some limb bones was almost always a corollary of processing the carcass (Enloe 1993). In exceptional circumstances, the bone marrow may have been depleted due to dietary deficiencies associated with the season of the kill, in which case

there would be little point in conducting marrow processing and the processing would end. However, if the bone residues indicate the remains of only minimal grease carrying elements and heavily fragmented bone it is reasonable to infer that processing for bone grease is indicated. By crushing the articular portions of the major limb bones, and simmering these residues, it is possible to extract the residual marrow and bone grease. The consequence of such processing is the destruction of specific portions of the faunal record and the preservation of bone elements that have little nutritional value (Binford 1978; Outram 2001a).

When bone is processed for marrow, the breakage of the midshaft causes a reduction in the overall identifiable bone present in the site and removes evidence of previous processing, for example cut marks. When bone is processed for the extraction of embedded marrow and bone grease, the element is further reduced, usually to the point of unidentifiable bone fragments. This would obviously remove all evidence of previous processing and, therefore, bone processing must be envisioned as a single pathway, which allows for the selection of several specific terminations. Thus, where the bone residues reveal largely whole elements found in a semi-articulated context, it is reasonable to infer that only the major muscle masses were removed. If the bone residues indicate that the larger limb bones, for example the humerus, tibia and femur, have been split open, it is reasonable to infer that some marrow processing is indicated.

According to Davis and Fisher (1990:254) "The fragmentary condition of the bones documents thorough processing to extract nutrients." Frison (1971b) also saw evidence for this at Eden-Farson (48SW304). There, "The bones at the site were all broken to the extent that not a single complete long bone was recovered" (Frison 1971b:266). "All [the bones] were subsequently crushed and boiled to recover all possible of the edible

portions" (Frison 1971b:261). Further archaeological evidence for marrow extraction is provided by Fisher and Frison (2000). They remark that "the fragmentary nature of the bones suggests that bone breakage to extract marrow was an important activity. Bone fragments might have been boiled to extract grease..." (Fisher and Frison 2000:96).

Archaeologically this can be seen in the presence of numerous distinct marks and fracture patterns left by the cultural processing of bones to extract nutrients. Choppers will leave clean-cut marks halfway through the bone, on the exterior. The bone then fractures from the end of the cut to the interior. A large number of long bones bearing the distinctive scars made by a hammerstone (grooved maul), including the obvious points of impact and associated bone flakes, were present at the Lost Terrace site (Davis and Fisher 1990:264).

Finally, in addition to the faunal evidence, archeological features can often provide proof of marrow extraction at a site. Davis and Fisher (1990:263) describe just such a feature "A basin-shaped feature at Lost Terrace containing distal ends of metapodials and phalanges suggests that they might have been baked, the soft tissues eaten and then broken open for final nutrients." These bone fragments may also have been boiled in order to obtain the residual marrow that cannot be shaken out of the ends of the marrow chamber, thus making a kind of soup.

"Pronghorn bone marrow probably was particularly sought after, since its fat content remains high in the spring compared to most other fat sources in either sex" (Bear 1971:583). Seasonal fat stress does not seem to be a big factor in altering the fat content of pronghorn bone marrow.

5.5.4.3 Bone Grease

Bone grease is the term archaeologists and anthropologists use to refer to fats contained within the structure of the bone itself, in particular cancellous tissue (Brink 2001:260). According to Brink (1997, 2001), fat deposits found within the bone tissue of large mammals, commonly called bone grease, constitute a significant source of nutrition and as such attracted the attention of prehistoric human hunters and carnivores alike. In order to gain access to this grease, which is mixed in with the bone tissue, they would have had to utilize an extraction process. This grease can only be adequately recovered by crushing the bones and then boiling them. A general definition of bone degreasing would be the process of smashing bone and boiling the fragments to release the grease. According to Cormie (1970:10) "Bone grease could have been used in pemmican, for cooking as butter, or even eaten alone while frozen. Perhaps it even had a use as a lubricant or waterproofing for skin bags, and there has even been mention of hair oil".

"The primary value of bone grease would probably be as a concentrated energy source. Its other seldom acknowledged benefit may be in its preserveability and therefore when other vitamin carrying, thiamine, protein, amino acid providing and glycogen sparing sources are in short supply or exhausted it might help delay or avoid deficiency conditions or the depletion of human body resources" (Vehik 1977:172). With regard to its vitamin carrying aspect, Vehik (1977) was the first to note that the fatty lipids of bone grease are an excellent source of fat-soluble vitamins A, D, E and K. Therefore, "grease rendered from bones by boiling contains not just calories in the form of lipids, which may be a small benefit by itself, but also trace nutrients in the form of vitamins and minerals" (Church and Lyman 2003:1082).

Much of the data surrounding bone grease and its production comes from three basic sources: ethnographic evidence, experimental archaeology or field archaeology. In understanding this topic the ethnological evidence provides the researcher with a glimpse into the lifeways of the Plains hunter-gatherer. Leechman's (1951) paper provides a first hand account of bone grease, by one of his informants, Julia McDonald from Old Crow in the Yukon Territories. Although not a Plains example of bone grease utilization and processing this account provides a valuable indirect example applicable to the Plains region. In fact, it was the first ethnoarchaeological work to specifically address the processes associated with bone grease production with specific comments on the extraction of grease by boiling small pieces of fragmented bone.

> Bone grease (in Old Crow) is made from caribou and moose bones. After the meat has been cut off, the bones are left for one day, which allows them to dry a little. If the bones were left for two or three days, the bone grease made from them would taste too strong to be pleasant. A caribou skin from which the hair has been removed is laid on the ground and an anvil stone is placed in the middle of it. The bones to be broken are placed on the anvil stone and smashed into little pieces, "as big as finger nails", with the back of an axe. In the old days stone hammers were used for this. The broken bones are then put in a kettle with a little cold water and placed on the fire. As soon as the water comes to a boil, cold water is added (snow in the wintertime) so as to keep the water simmering rather than boiling violently. The purpose of this is to allow the oil and grease rendered out of the bones to float to the top, which it would not do if the water were boiling vigorously. The grease is skimmed off and put in a separate vessel, usually the small inner part of a caribou's stomach. Here it will keep quite well for as much as two or three years. Some of it was used for making the best pemmican, for pemmican was made in this part of the Yukon, some of it was kept for daily use in cooking (Leechman 1951:355).

Leechman even goes so far as to provide the researcher with an expiration date with regard to grease producing bones. Stating that "apparently bone grease had to be made

within about one day of a kill, otherwise the grease would taste too strong" (Leechman 1951:355).

The next ethnographic account was published by Zierhut (1967), and is based on fieldwork conducted among the Calling Lake Cree of Northern Alberta.

> Along with the fragmented bones produced in the extraction of marrow process, bones containing little marrow are also used to make bone grease. These bones are broken in the same manner as used to extract marrow, including the use of a log or anvil. The only bones not broken are the carpals, tarsals and phalanges. Each rib is broken into sections 2 to 6 inches in length; the ilium, ischium, and pubis are broken from the innominate, leaving the acetabulum intact; the neck of the scapula is broken off, as is the spinous fossa just below the acromion. The vertebra are not altered greatly, however, the spinous processes may be removed. The base of the skull, which was broken away to remove the brains, and the fragmented maxillary and nasal bones are also utilized to make bone grease. Bones containing little marrow are broken into small pieces for use in making bone grease. The process of making grease is as follows: all bone fragments are gathered and placed in a large pot containing water. The bones are boiled very slowly and the fat which floats to the top is collected and eventually eaten (Zierhut 1967:35-36).

The above-mentioned method of making bone grease is very similar to that described by Leechman for the Loucheux of Old Crow in the northern Yukon. Kehoe (1967) provides the most directly applicable account of bone grease preparation, for the Plains region. He interviewed Mae Williamson, a prominent middle-aged Blackfoot, who explained that,

> Bison bones were chopped and boiled for bone grease because the grease thus obtained was a 'soft' oil, which remained liquid and never became harder than soft butter. Therefore, it was good for hair oil, moistening pemmican, etc. Ordinary tallow fat (from bison fat) becomes too hard for these uses. The femur and humerus were best for 'bone butter'. They were smashed with tough stones that would not chip, such as berry-mashers. In winter, snow would be thrown into the pot of boiling bone 'soup'. The snow would cause the fat to cake on top of the pot so that it could be removed easily. Wooden spoons or horn could be used to remove the fat. The fat was placed on ice and would coalesce together. It was often added to pemmican. (Kehoe 1967:70)

Later ethnographic accounts provided smaller details often overlooked by some of the larger earlier works. Three good examples of this can be found in the works of Dyck (1970), Bonnischen (1973) and Schaeffer (1978). Dyck states that "Once the marrow has been obtained from both sections, the remainders of the shaft are broken into smaller pieces to be used in the preparation of bone grease. The only recognizable remaining potions of the bone are the distal and proximal ends. Bones containing little marrow (including ribs, ilium, ischium, pubis, neck of the scapula and spinous fossa) are broken into smaller pieces for use in making bone grease. The only bones not broken are the carpals, tarsals and phalanges" (Dyck 1970:16). Bonnischen provides the reader with evidence for the initial steps involved in grease manufacture; "The process of making the grease begins with the removal of the periosteal sheath either by placing the bone near an open fire or by scraping it off by hand" (Bonnischen 1973:10).

It is a commonly held opinion among those who have witnessed or attempted to replicate bone degreasing activities that there is a high investment for minimal return associated with this extraction process. "The volumes of bone, stone, and fuel which are consumed in the process of obtaining bone grease surely made it one of the most costly resources associated with bison processing" (Binford 1978:159). Leechman (1951:355) "noted that in order to obtain one buffalo bladder of grease which weighed about 12 pounds the marrow bones of two buffalo would be required. In fact, the more bones available, the more efficient the process of bone-grease manufacture becomes. For the production of bone grease cancellous bone needs to be saved up until a sufficient amount is present to make processing worthwhile. Church and Lyman (2003:1082) view "grease [as a] 'bonus resource' if the animals were procured for other resources such as

meat, hides, sinew and bone." Also, if the bones were broken for marrow extraction, this would reduce the cost of breaking them for grease extraction.

Binford (1978) has argued that an aboriginal preference exists for one type of grease, white grease, found in quantity in the long bones of large land animals. Specifically, white grease is found in the appendicular portions of the skeleton, especially the articular ends of long bones. "Non-long bone elements such as ribs, vertebrae, and mandibles typically yield a yellow grease low in fatty acids, in contrast to long bones, which yield quantities of white grease high in fatty acids" (Brink and Dawe 1989). Binford (1978) maintains that one fatty acid, oleic acid, was the primary and best tasting acid in bone grease. In fact, oleic acid is by far the most dominant fatty acid in the grease within the bones. Brink (1997) confirmed this by stating that the types of fatty acids in bone are saturated and unsaturated, which consist largely of oleic acid. This may be so; however, prehistoric hunters certainly had no way of separating out any of the acids in bone grease.

According to Kooyman (1981) the processing of bone for grease should be readily recognizable by the presence of a relatively large number of small bone fragments from an area. This is based on the fact that more grease can be extracted if the bone is highly fragmented, this being a function of more surface area. Conversely, small bone chips are not desirable by-products during butchering or marrow processing as they are difficult to remove from meat and marrow. This is obviously more of a concern with regards to marrow, and both Binford (1978:154) and Yellen (1977:282, 293, 327) noted that care was taken to minimize this problem during marrow processing. Needless to say, butchering and marrow extraction evidence can easily be obscured by subsequent bone grease production.

In support of the above statement Vehik (1977:169) notes that "ethnographically bone grease and/or soup seems to be the only reason prehistorically that bone was finely crushed." In 1947, [Leechman] while working on an archaeological site in southern Ontario, noticed large quantities of bones broken up into small fragments and stated "After my experience in Old Crow it was easy to recognize them as the waste material left over from making bone grease. It seems probable that this process was familiar to many of the aboriginal people who hunted big game" (Leechman 1951:356).

Having said this, Church and Lyman (2003) disputed the fact that bones used for grease extraction had to be fragmented into very small pieces to be effective. Their paper discussing the quantification of conventional wisdom regarding grease extraction from white-tailed deer bone fragments, concluded that very small bone fragment size is not necessarily needed to be efficient. "Long bones need to be broken into pieces smaller than complete diaphysis and epiphysis" (Church and Lyman 2003:1080), with 1-8 cm being okay and 5 cm being optimal. "Long bones simply cut into three pieces ... were the least efficient as it took 5 hours to produce 80 percent of renderable grease. While bone fragments ranging in size from 1-4 cm in diameter produced eighty percent of renderable grease in two-three hours of boiling" (Church and Lyman 2003:1081). They were also able to conclude that the amount of grease extracted from the femur, humerus and tibia are the same statistically.

This size range would also appear to be supported with evidence from the archaeological record. Bonnichsen (1973:10-11) reports that ribs and thoracic vertebrae used for bone grease were broken into 5-15 cm segments. Vehik (1977:170) comments that the thoracic [neural spines] were broken into 5 cm sections whereas other vertebrae were cut in half. Vehik (1977:172) finishes by stating that "archaeological evidence for

bone grease manufacturing can only be the presence of small pieces of unburned animal bone. In addition there should be negative evidence for the legs, feet, ribs and vertebrae as these bones would have been battered beyond recognition in preparation for boiling, with the possible exception of the articular ends." Milne (1988) disputes Vehik's comment regarding small pieces of unburned animal bone. She stated that "A by product of bone grease preparation is tiny fragments of bone which are unburned, burned or calcined" (Milne 1988:54).

Binford (1978:159) also describes bone debris resulting from bone grease extraction: "The archaeological remains of such an operation are unmistakable. There is a large pile of pulverized bone approaching the appearance of bone meal. There is generally a dump to one side of a substantial hearth containing large quantities of ash." Finally, it has been suggested that bone grease was manufactured at the Gowen I site (FaNq-25), and at the Cactus Flower site (EbOp-16). "It is in sites such as these that we find the first evidence of bone boiling and grease extraction, as marked by the presence of fire-cracked rock, rock- and bone-filled pits, and large amounts of macerated, sometimes singed, burned bone and bone spill piles" (Reeves 1990).

Another factor involved in the archaeological interpretation of grease extraction is the resulting preferential bone destruction. The bone element portions that would be preferred and thus destroyed as a consequence of bone grease rendering are also the portions that would be susceptible to the taphonomic agencies that destroy bone. Evidence for this can be seen at sites such as Boar's Tusk where a bone fragment filled pit was found full of size graded bone refuse from secondary processing (Fisher and Frison 2000).

Degreasing is a destructive process and evidence of this activity is inferred through an absence of the preferred portions of the skeleton. "Hence, the higher the grease content the more easily long bone ends can be destroyed and the lower its survivorship ..." (Morlan 1994b:772). Brink (1997:267) states that this might be due to the fact that the "volume and density of bone is closely related to actual grease abundance."

Metacarpals are generally poor sources of bone grease and this is reflected in the relatively good archaeological survivorship of these elements (Brink 1997). This trend was especially prevalent in the processing area at Lost Terrace (24CH68), with the proportions of surviving long bone ends reflecting selective removal or destruction of those portions. "The proximal end of the humerus and tibia and the distal end of the femur are almost absent, whereas distal ends of metapodials are abundant and often intact" (Davis and Fisher 1990:264). It seems likely that the missing long bone ends had been so thoroughly processed for bone grease that they are unidentifiable. This is due to the fact that they contained the " most concentrated reserves of bone grease" (Brink and Dawe 1989:135).

The most accurate estimate of the original composition of a faunal assemblage will be obtained from the counts of mid-shaft (diaphysis) segments as these bones are affected little by scavenging. Grease rich bones are also the most likely to undergo natural deterioration, resulting in faunal patterns that mimic intentional human selection. According to Cormie (1970), the absence of the tibia, femur, humerus, radius and ulna indicate the preparation of bone grease. Those long bones are often only represented by a selection of proximal and distal ends. It also seems most likely that the thermally-altered rocks (present at the Lost Terrace site) are fired, broken river cobbles used to heat hide-lined pits used in the rendering of bone grease (Davis and Fisher 1990:264).

In addition to the valuable information regarding diet and subsistence that can be recovered from a fragmented faunal assemblage that was utilized for bone grease extraction, bone boiling could be a potential indicator of the season of resource use. This is based on animal nutritional stress cycles, with pronghorn providing a good source of fat in the spring (Bear 1971:583). Miller and Sanders (2000:44) stated that "a herd dominated by females, [such as those at] Trappers Point may have been, would be a good source of fat, because females tend to maintain higher fat levels throughout most of the year."

Binford (1978:683) suggests that "ribs and vertebrae, along with mandibles, are less desirable than other elements for bone-grease manufacture but might be used in times of stress." At the Lost Terrace site, the extremely intensive utilization of the pronghorn carcasses could indicate a winter season of occupation based on the production of bone grease (Davis and Fisher 1988). In fact, even "vertebrae seem to have been broken deliberately, perhaps prior to boiling for bone grease extraction" (Davis and Fisher 1988:109). Brink (1997), Logan (1998) and Church and Lyman (2003) all agree with this and suggest that bone grease production may provide a clue as to the season of site occupation.

Unlike the evidence left at processing sites, at permanent settlement sites, for example long-term campsites, little evidence would remain related to bone grease manufacturing activity patterns. Only if such activity was one of the last activities conducted at the site and the by-products were not removed to a trash area might there be some archaeological evidence for bone grease manufacturing patterns (Landals 1991).

Small fragments of long bones often accompanied by large quantities of fire-broken rock found in a Plains camp or processing site will often lead a researcher to conclude that bone grease production was carried out at the site. A great number of different activities can result in fragmentation. The context of the fragmented specimens and the elements and species represented by them, if that can be ascertained, must be carefully evaluated in determining the cause or causes of the breakage. For example, the extreme fragmentation of fauna at sites such as Lost Terrace (Davis and Fisher 1990) is presumed to be a combination of two primary forces.

Grease was an essential ingredient in the manufacture of pemmican, for dried meat, on its own, is insufficient to sustain a healthy balance of protein and carbohydrate intake. Assuming that the physiological makeup of prehistoric populations did not differ substantially from historic groups, and accepting the view that subcutaneous fat was inappropriate for pemmican manufacture then the conclusion that marrow and grease processing was vital to the northern Plains lifeway is unavoidable.

5.5.5 Consumption

It may be assumed that a considerable amount of bone will have been cooked, either as a consequence of roasting or of boiling for soup or stew. Bones may also be boiled for glue or to extract the fat. Unfortunately, direct evidence for the cooking of meat is rare, and evidence to distinguish cooked from uncooked bone is lacking (Nicholson 1996:527).

On the northern Plains, fire pits are often considered to have been used for cooking food products. Stones were placed on a bed of hot coals in the pits. When properly heated, the stones served as a source of heat for cooking. Whatever was to be cooked could have been put in a green hide, animal paunch, or fiber bag, and placed directly on

the hot stones. This package would then be covered with earth or some sort of mulch, and left for a period of time, which could have been several hours or even a day. With practice, this can be done without burning or contaminating the food with the surrounding matrix. The initial heat and subsequent reuse ultimately fractured the stones to the extent that they were of no further use and another pit was dug and the process repeated, or the original pit was cleaned out and fresh rock was used. Pits of this nature were also used to heat stones for boiling during the Late Archaic right into the Contact period. In this case, there was another pit or pits nearby where stone boiling took place. The latter was usually lined with a green bison hide or paunch. Stones of proper size arranged in a small circle with a hide or animal paunch liner could also serve as the pit (Frison 1991a).

Site formation processes are fundamental in determining the patterning that is observed in archaeological sites. In addition, a valid interpretation of archaeological remains depends upon an understanding of how these remains came to their final resting-place. Cooking is one of the modes of bone modification and transportation that can affect a faunal assemblage. The differing taphonomic features exhibited by cooked bone and uncooked bone in relation to fracture patterns, location of cut marks, patterns of burning damage and relative frequencies of skeletal elements within bone assemblages all provide evidence for archaeological interpretation. In fact, cooking is perhaps the most common pre-burial taphonomic transformation that occurs to bone (Roberts et al. 2002:485).

When considering cooked bone, we are mainly dealing with three different processes. First, burning or incineration of bone, if the bone is in direct contact with the fire or an intense heat source. This type of process is more often associated with rubbish disposal

than with cooking. "Research has demonstrated that areas that contained concentrated ash and faunal remains were most likely trash disposal areas" (Kent 1981:368). The second process involves roasting or baking, where the bone is protected from the heat source via insulating flesh. Finally, boiling, where the bone and flesh are heated at a constant temperature, moderated by liquid.

One of the most obvious indicators of bone modification caused by heating, are the signs of charring or calcining from exposure to fire. However, the exact implications of burning are often unclear. The depositional context of the faunal assemblage plays an important part in determining the human role with regard to this transformation process. For example, burned bone found in a cave would most likely have occurred through human initiated causes. That same burned bone found at a site situated along a flood plain or lake margin may have been transformed by human or natural causes or both. Finally, a burned bone assemblage found out on the open grasslands would most likely have been transformed by natural fire, unless associated cultural materials dictated otherwise (Klein and Cruz-Uribe 1984:6).

Many archaeological sites on the Plains, have yielded large quantities of fragmented blackened and calcined bones, and the interpretation of these specimens is important. Some scholars dismiss all blackened bone as "burned", and attempt no interpretation beyond the conclusion that some of the bones were scorched in cooking. However, the oxidation or reduction-firing atmosphere could also have some significance with respect to bone. Furthermore, it can be argued that fully blackened bone or calcined bone is not a product of cooking at all. Bone surrounded by meat does not char or blacken until the meat itself is thoroughly burned. This means that bones that are charred in certain areas

and "clean" in others may represent cuts of meat from which the charred portions were protruding.

Charring is not simply a staining of the bone surface with smoke particles. It is a physical alteration of the organic element, and it need not reflect direct contact with a flame. Bone buried beneath a fire can also become charred; and the black colour is indicative of a reducing environment. Bone that is brittle and charred completely through to the marrow cavity may well indicate such post-burial conditions and be of no cultural significance at all. Landals (1991) states that burned bone may relate to natural fires, if it is only present as scattered fragments, rather than in dense lenses. Many of the blackened and calcined bones, especially small fragmented ones, were probably thrown into the fires as a means of efficient garbage disposal (Wilson and Davis 1978:331-332).

Burned and calcined bones, which occurred at the Boar's Tusk site (Fisher and Frison 2000:91-93), seem to record the complete incineration of surface bone middens. This condition may also be the result of prairie fires, but it is reasonable to speculate that intentional firing may have been part of the preparation for a subsequent drive. Relatively fresh middens would have had strong odours that might have disrupted subsequent drives. "Burned bone within an archaeological context may result from cooking, use as fuel, or from burning refuse. Burning resulting from cooking should be differential, that is, only on the exposed, cut ends of bones. The latter two practices should produce bone fragments that are essentially burned over their entire surface" (Kooyman 1981:73).

According to (Brink 2001), bison have quite greasy bones relative to other terrestrial game, however, the author has not found a reference specifically addressing the grease

content of pronghorn bone. In fact, during historic times bison long bones were sometimes burned as a source of heat on cold nights.

To segregate these processes, Binford (1978:303) has suggested that bones would be selected for fuel as a function of their grease value. The higher their grease value or quantity of grease they have stored within them, the better they will burn. If burned bone from a site or activity area conforms to the grease index, the use of bone as fuel is likely. The general burning of refuse would not result in any particular selective patterning.

The cooking process of roasting or baking would leave little in the way of an archaeological signature. If the bones had been boiled or were contained in flesh being roasted, they would not exhibit indications of these processes, especially in view of the low temperatures and relatively short cooking periods probably used by the Indians. Often an archaeological signature such as "A number of chopped bone fragments (limbs prepared for the extraction of bone grease) and some metapodial bones that had been charred (i.e. incompletely burned) were uncovered with a few small fragments of completely incinerated bone" (Kehoe 1967:71). Since these are commonly found mixed with ash and charcoal, it is often the case that they had simply been dumped out of a cooking vessel and into the fire that was being used to cook them: in effect this is a form of trash disposal. This type of feature and its associated bone assemblage is often mistaken for the initial process of cooking meat rather than the disposal of waste. However, the above signature might also be used to describe the archaeological evidence of boiling and/or roasting. This said, "Roasting and boiling were the principal means of cooking foods, the latter being the favorite method" (Kidd 1937:105). According to Kidd "... the Blackfeet, at least liked to have roasted foods thoroughly done; boiled

meats on the other hand, were merely heated thorough, being left but five minutes in the water" (Kidd 1937:105).

The most effective way of identifying cooking-related alteration would be through structural analysis of the bone. Baking would be expected to produce denaturing of collagen fibrils and break down of the collagen-mineral relationship at temperatures of 60-80 °C. "In roasting or baking temperatures do not exceed 85 °C around the bone" (Roberts et al. 2002:486). It could, however, be expected that such altered fibrils would be attacked by a wide range of micro-organisms, not just those capable of producing a collagenase, and would be leached in preference to undenatured collagen, which in turn would cause the preferential destruction of all cooked bone (Roberts et al. 2002). Experiments have also demonstrated the dramatic reduction in the strength of bone consequent upon heating (Nicholson 1996). It is therefore unclear why baked bone sometimes survives in a similar condition to fresh bone, although increased surface hardness caused by heating bone and cooling gradually may be a contributing factor. In contrast, boiling encourages hydrolysis and leaching of organic material and, once freed from its intimate association with the collagen, leaching of mineral into solution. The preferential decomposition of boiled bone is therefore to be expected, with the rate of destruction dependent upon structure and the duration of boiling.

Of the cooking methods used prehistorically, boiling was a method used for both the extraction of bone nutrients and for food preparation. Examples of this usage abound in the historic literature. Kidd (1937:180) describes the contents of a Blackfoot boiled soup "The rump made the most esteemed soup; but the head, cut and pounded to pieces, and the bones or dried stomach could also be used." This observation, made by William Francis Butler in 1872, illustrates the boiling process used on the Plains;

> "Their manner of boiling meat was as follows: a round hole was scooped into the earth and into the hole was sunk a piece of rawhide; this was filled with water and the buffalo meat placed in it, then a fire was lighted close by and a number of round rocks made red hot; in this state they were dropped into or held in the water which was thus raised to a boiling temperature and the meat cooked" (Bryan 1991:79-80).

Cracked bones were also boiled in the above-mentioned manner in order to extract the grease and marrow.

Cooking can be considered an analogue for burial diagenesis, with similar patterns obtained as are observed in archaeological samples. Archaeological bone that had been heavily boiled is unlikely to survive intact throughout an entire episode of burial. This is due to its high porosity and reduced mechanical strength. However, it will have little organic content to attract further scavenging damage or microbial attack and its altered, more stable, mineral organization may be less reactive in the burial environment.

5.6 Bone Survivorship Methodology

This section provides an archaeology case study to explore the relationship between bone density and preservation. Lyman's (1985:226) research indicates that bulk density (the ratio of the weight of a volume of substance to the volume of that substance including the pore space volume) is causally related to the potential of a bone to survive destructive forces.

Density values derived from Lyman (1982, 1984) are compared with rates of element survival from two northern Plains archaeological pronghorn assemblages, EbPi-75 and DlOu-72). (See Appendix E for a complete list of scan site locations and bone density data utilized in these calculations.)

If differential destruction caused the observed differences in bone counts at EbPi-75 and DlOu-72 sites, then bone frequency should correlate with bone density. That is, the

more dense bones (or portions of a bone) should have higher frequencies in the assemblage and the less dense bones (or portions of a bone) should have lower frequencies because they are more susceptible to destruction. Bone density values for modern pronghorn (Lyman 1984) are used here to assess the bone density hypothesis.

The sample size for individual skeletal elements at EbPi-75 and DlOu-72 is large enough for statistical analysis (e.g. paired *t*-test), therefore, statistical analysis and informal comparisons between the EbPi-75 and DlOu-72 site assemblages and Lyman's (1984) bone density data can be undertaken.

Most long bone midshafts have very high or high density. The relatively common occurrence of long bone fragments at EbPi-75 and DlOu-72 sites meets expectations for density-mediated bone attrition. The metacarpal presents a slightly anomalous case because it ranks very high in density but is relatively uncommon compared to other long bones in the pronghorn assemblages. Vertebrae have among the lowest bone density values, especially the atlas, axis, the other cervicals, and sacrum. The low frequency of vertebrae at EbPi-75 and DlOu-72 therefore meets expectations for density mediated bone attrition. Ribs, however, have a density that lies approximately midway between the extremes, yet they are uncommon at both EbPi-75 and DlOu-72. The abundance of first, second and third phalanges conforms to expectations based on density-mediated bone destruction. The first phalanx has a density that exceeds any vertebra, the second and third phalanges have a density that exceeds that of the cervical vertebrae (including the atlas and axis).

The present study indicates that density is an extremely important variable in determining survival of bone in archaeological contexts. Even with the multiplicity of factors involved in forming the pronghorn assemblages, a high correlation between

density and survival is found. It is evident from this study that bone density is important for predicting which elements will survive. Absence of certain segments, where bone mineral density is low, should be expected as the postmortem interval increases or where environmental conditions are particularly destructive. The absence of bone that is more densely constructed, however, suggests that some form of selection, perhaps by opportunistic scavenging or deliberate human modification of the remains, has occurred.

The results show a high positive correlation between density and survival and provide a unique perspective on pronghorn procurement on the northern Plains and upon the process of density-mediated survival of bone.

Differential bone density, combined with other pre- and post-depositional processes mentioned in the previous sections, is the most plausible explanation for the limited number of pronghorn bones found in northern Plains faunal assemblages.

5.6.1 Paired *t*-Test

The paired *t*-test is used when an observation involving the difference between scores on the same population of data is desired (Madrigal 1998; Thomas 1986). In this case, the population is the skeletal pronghorn elements from EbPi-75 and DlOu-72, and the observations represent the bone density rankings and archaeological sample occurrence rankings.

The difference between cases is computed as:

$$d = \sum y_{1i} - y_{2i}$$

Where d is the total difference, y_1 is the observation for the first sample, y_2 for the second sample. This d score is compared to the *t*-test statistic, which is computed as:

$$t = \frac{\bar{y}_1 - \bar{y}_2}{S_{\bar{y}_1 - \bar{y}_2}}$$

Where the denominator is calculated by:

$$S_{\bar{y}_1 - \bar{y}_2} = \sqrt{s^2_{\bar{y}_1} + s^2_{\bar{y}_{12}} - 2rs_{\bar{y}_1}s_{y_2}}$$

Where s^2 is the variance for the variables, r is the correlation between the variables and s is the standard deviation for the variables. The *t*-test statistic is calculated for n-1 degrees of freedom.

Possible hypotheses include:

H_0 – There is no statistically significant difference between bone density rank and archaeological sample rank.

H_a– There is a statistically significant difference between bone density rank and archaeological sample rank.

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	DensityRank	12.2593	27	6.28547	1.20964
	ArchRank	10.8148	27	5.21121	1.00290

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	DensityRank & ArchRank	27	-.089	.659

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	DensityRank - ArchRank	1.44444	8.51394	1.63851	-1.92356	4.81245	.882	26	.386

In this case, with 26 degrees of freedom, at the level of significance of 0.05, the results do not allow for the rejection of the null hypothesis, and it cannot be said that there is a significant difference between the bone density rank and the archaeological sample rank. Therefore, this result indicates that there is a relationship between bone

density and the occurrence of pronghorn bones in the archaeological sample. In fact, based on the research presented here, the relationship seems to be a significant one.

5.7 Conclusion

The value of bone density studies is that they can reveal incidences of differential survivorship, which can result in the erroneous interpretations of elements based on frequency. The results of this research would seem to indicate that all things being equal except bone density, the denser bison bone would preferentially survive in the archeological record longer than the less dense pronghorn elements.

In addition, when all of the other pre- and post-depositional factors are taken into account the relative lack of pronghorn faunal elements in the archaeological record may be the result of taphonomic factors. These factors would be compounded on younger animals based on the fact that their bones are more porous and therefore subject to more rapid deterioration due to chemical and mechanical erosion.

In summary, density-mediated destruction as an explanation for skeletal element frequencies at EbPi-75 and DlOu-72 is consistent with the numbers of vertebrae, long bones, carpal, tarsals and phalanges present in the samples. This does not, however, confirm that density mediated destruction is responsible for the observed bone frequencies. Specifically, the model of density-mediated bone destruction is unable to explain the observed frequencies of ribs in the samples.

The fragmentary nature of the bones suggests that bone breakage to extract marrow was an important activity at EbPi-75 and DlOu-72. Bone fragments might have been boiled to extract grease, as the excavations produced strong supporting evidence in the form of large quantities of thermally-altered rock, charcoal and ash. However, it cannot be assumed or demonstrated that all bone breakage resulted from purposeful human

activities. Some bone breakage probably occurred post-depositionally from taphonomic factors such as weathering, trampling, carnivore attrition and decomposition. For example, some long bone shaft fragments appear to have been split into numerous splinters from weathering, while others have gnawmarks that can be attributed to carnivores. In addition, the burning of bone, followed by trampling, probably caused further bone fragmentation.

It can be stated that archaeologically the fragmentation of pronghorn bone is common. In addition, pronghorn long bone elements are generally broken to some degree, often in patterns indicative of green bone breakage. Evidence of butchering marks occurs on meaty and non-meaty elements, however, they are not present 100 % of the time on animals where cultural utilization is known to have taken place.

While the basic assumption that hunters and gatherers use large game carcasses in a manner so as to maximize the return of nutritious food can be supported, it is also important to recognize that the real world is far more complex than that which can be modeled in a simple ranking. However, it is also fair to assume, as Binford (1978) does, that most carcass parts are used for food in a rational manner based on their relative ability to sustain life.

CHAPTER SIX

Analysis of Pronghorn Assemblages from Little Bow Reservoir Site (EbPi-75) and Bow Island Site (DlOu-72)

6.1 Introduction

It is the intent of this chapter to synthesize the zooarchaeological data from EbPi-75 Stone Circle 1, 4, 25 and Stone Feature 18, along with Components 1 and 2 from DlOu-72, in order to reveal evidence of small-scale pronghorn procurement. As these two recently excavated sites have generated considerable archaeological evidence for pronghorn procurement on the northern Plains they represent a valuable addition to the small-scale hunting knowledge base.

These site complexes are unique not only for their depositional integrity but for the variety of *in situ* artifacts pertaining to pronghorn procurement as well. The artifacts indicate an occupational time frame that spans the Late Prehistoric into the Historic period. While pronghorn procurement sites from this time span are the most abundant, they are far from common and any information recovered represents an important addition to the archaeological dataset as a whole.

With regard to this research, evidence for differential butchering practices affecting assemblage formation and assemblage composition will be studied. In addition, differential survivorship, carcass recovery strategies, and taphonomic and preservation issues will all be topics pertaining to this chapter and hopefully evident in these site assemblages.

6.2 Methods

The two pronghorn assemblages from EbPi-75 and DlOu-72, were recatalogued using a combination of the methodologies presented in *A Guide for the Classification of Faunal Remains from DkPi-2, The Highway 2/3 Junction Site* (Unfreed 1993), and the *Procedures Manual for the Oldman River Dam Project* (Brumley n.d.). Additional pronghorn remains from EbPi-75 and DlOu-82 were identified by comparison with known skeletons in the University of Saskatchewan comparative osteology collection, which is managed by the Department of Archaeology. Published osteological keys and anatomical references, including Ford (1990), Gilbert (1990), Lawrence (1951), Olsen (1973), were also consulted. The terminology for this analysis followed the protocol outlined in Lyman (1994a). The faunal element abbreviations used in the cataloguing and analysis are presented in Appendix C.

The following analyses and interpretations are based on the taxonomic identification of bone fragments via their morphometric characteristics. As no other species of similar body size (e.g. deer or Rocky Mountain bighorn sheep) have the same characteristics as pronghorn, all unidentified medium ungulate fragments have been recatalogued as pronghorn. Additional supporting evidence for this assumption, regarding the identification of the EbPi-75 medium ungulate fragments, comes from the fact that previously researchers have also failed to identify any ungulate other than bison and pronghorn in the site archaeofauna.

Unless specified otherwise, the following reanalyzes and discussions pertain exclusively to the pronghorn and presumed-pronghorn component of the faunal assemblage.

6.3 Little Bow Reservoir Project (EbPi-75)

This segment of the research project will focus on the zooarchaeological material uncovered from EbPi-75, Stone Circle 1, 4, and 25, and Stone Feature 18 (refer to Figure 3.7, Chapter 3), with particular attention being paid to the pronghorn antelope (*Antilocapra americana*) remains. These remains have undergone cleaning, conservation, cataloging and initial classification by the Fedirchuk McCullough & Associates Ltd. staff in their Calgary laboratory facilities.

6.3.1 Archaeological Features and Pronghorn Faunal Assemblage

The archaeological investigations of the various loci at EbPi-75 yielded numerous faunal remains as well as an extensive artifact assemblage. Outlined below are the descriptions of the four EbPi-75 features, along with pertinent faunal data relevant to this thesis.

Stone Circle 1 is situated in the southern cluster of features. It is an average sized stone circle (4.7 m diameter), composed of 15 rocks, with a well defined but lightly demarcated perimeter (Head et al. 1989:145) (refer to Figure 3.7, Chapter 3). The perimeter rocks were more deeply buried than rocks at many of the other features and cultural material was concentrated at a depth of ca. 9 cm below surface, beneath the well defined tan silt band, indicating that this stone circle dates to an earlier time period than the major protohistoric occupation of the site (Landals and Tischer 2001:218). This may explain the sparse distribution of the perimeter rocks, which could have been subject to reuse during the subsequent occupation(s) (Landals and Tischer 2001:218).

There was no clear evidence for a hearth in the assessment unit, however, a light scattering of tiny charcoal fragments was noted across the floor, and this stone circle contained a relatively high proportion of thermally-altered rock in comparison to other

stone circles. It is possible that the hearth was missed due to unit location. The assessment yielded numerous lithic artifacts, thermally-altered rocks and a 746 piece pronghorn and medium ungulate faunal assemblage. The faunal assemblage is comprised of 474 small fragmentary pieces identifiable only as medium ungulate and 272 identifiable pronghorn remains. The faunal material was thermally altered,

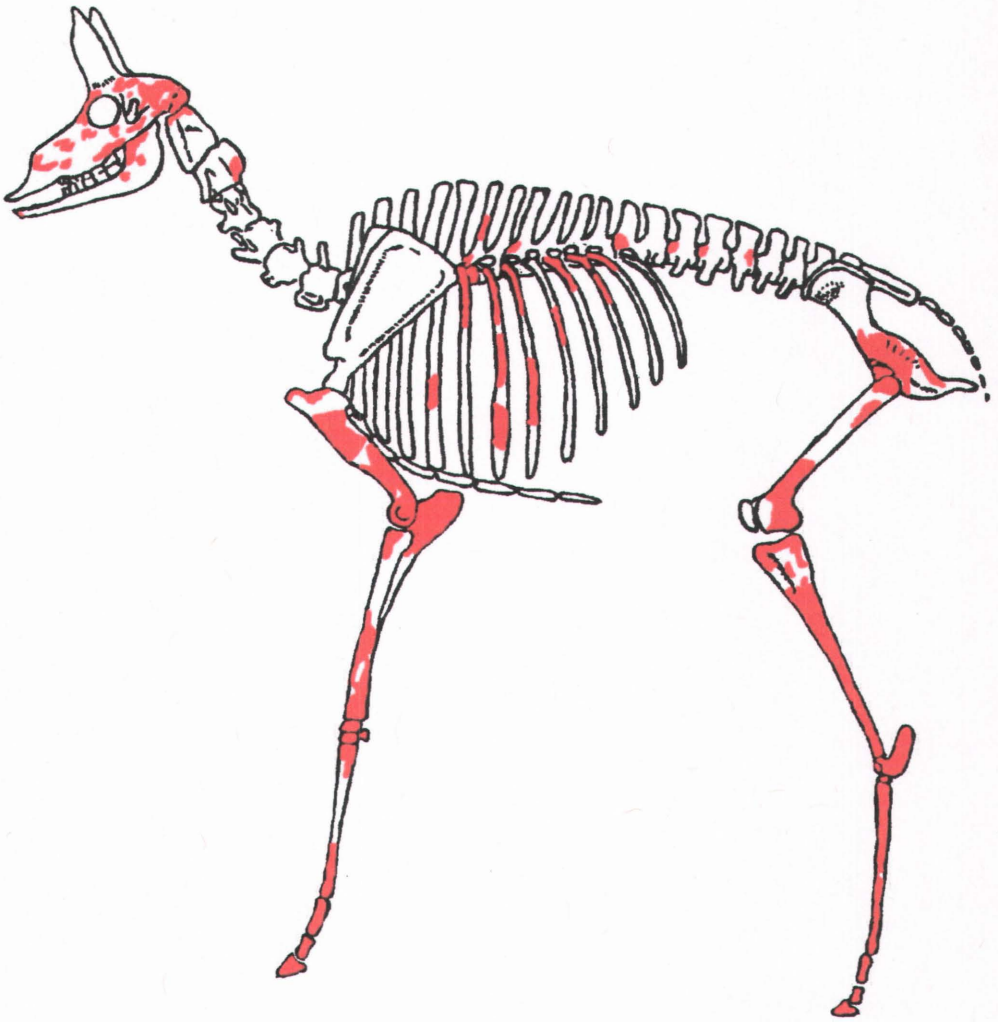


Figure 6.1 Generalized skeleton of a pronghorn showing skeletal portions recovered at EbPi-75, Stone Circle 1 (adapted from figure 8 in Davis et al. 2000:63)

both burned and calcined, and contained spirally fractured bone, bones with metal cutmarks and carnivore gnawing. Stone Circle 1 had a MNI value of 4, based on the left unciform, representing at least 4 adult individuals. Refer to Figure 6.1 for generalized skeletal diagram indicating faunal elements recovered at Stone Circle 1.

Stone Circle 4, in the southern cluster, is a very large (6.2 m diameter and 85 rocks), well defined feature which exhibits a shallow depth of burial (Head et al. 1989:147) (refer to Figure 3.7, Chapter 3). Head et al. (1989:147) recovered 86 burned/calcined bone fragments from an initial shovel test, and subsequently excavated a one by one meter assessment unit. This unit yielded only four additional fragments; however, it was placed well to the south of the productive shovel test. The 2000 assessment unit was placed closer to the productive shovel test and intercepted a well-defined hearth comprised of a circular concentration of burned/calcined bone, charcoal, and ash. A small fragment of red ochre was also collected from the hearth periphery. Of interest was the stratigraphic positioning of the hearth. The occupation floor containing the hearth were situated at approximately 4 cm below surface, above the tan silt layer, indicating that this large, shallowly buried feature postdates Stone Circle 1. It is possible that the large number of perimeter rocks is a reflection of this ring dating to the most recent occupation of the site (Landals and Tischer 2001:228).

The assessment yielded a 747 piece pronghorn and medium ungulate faunal assemblage. The faunal assemblage is comprised of 614 small fragmentary pieces identifiable only as medium ungulate and 133 identifiable pronghorn remains. The faunal material was thermally-altered, both burned and calcined, and contained spirally fractured bone, bones with cutmarks and carnivore gnawing. In addition, 2 bone fragments exhibited acid etching caused by carnivore digestion. Stone Circle 4, has a

MNI value of 2, based on the right distal tibia and left radial carpal. This value represents 2 adult individuals. Refer to Figure 6.2 for generalized skeletal diagram indicating faunal elements recovered at Stone Circle 4.

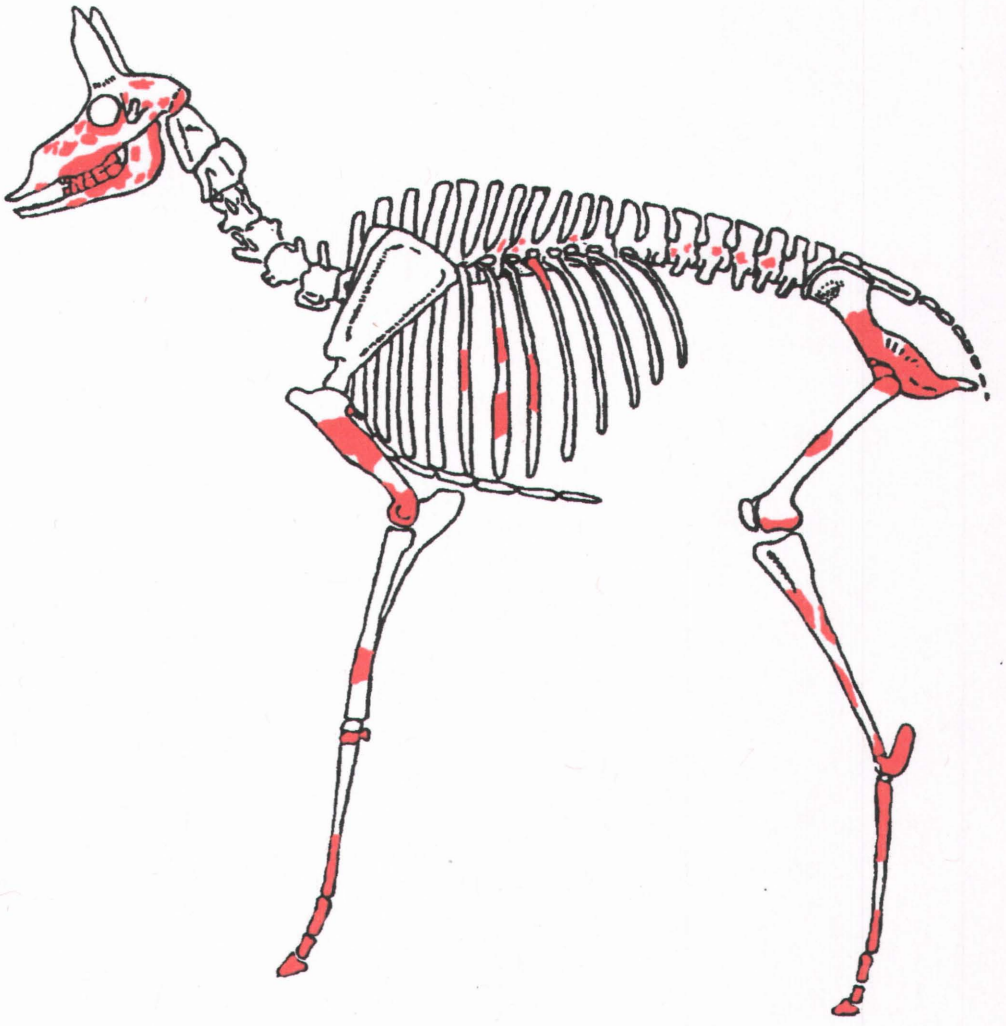


Figure 6.2 Generalized skeleton of a pronghorn showing skeletal portions recovered at EbPi-75, Stone Circle 4 (adapted from figure 8 in Davis et al. 2000:63)

Stone Circle 25 was the last of the newly discovered features in 2000 and was among the most interesting. It is a small, very sparsely represented circular concentration of

rock which is deeply sodded-in (refer to Figure 3.7, Chapter 3). The feature is also situated on a noticeable slope, rendering interpretation of surface rock distribution more difficult (Landals and Tischer 2001:262).

The assessment unit intercepted a small hearth represented by a basin-shaped area of oxidized soil with a few pieces of charcoal and blackened soil. The hearth and related cultural material are clearly beneath the flood deposited tan silt unit, and thus predate the occupation represented by Stone Circle 4. Stone Circle 25 may date to the same period as nearby Stone Circle 1 and Stone Feature 18. Of considerable interest is the discovery of a long thin ferrous metal rod directly within the hearth feature. While this item is of unknown function, the presence of this metal artifact indicates that stone features from both the earlier and later occupation period date to the Protohistoric Period. Given the mechanics of flooding, the two occupations may be separated by as little as one year or as much as one hundred years.

No lithic artifacts or thermally-altered rock were recovered from the assessment; however, the faunal assemblage proved to be of great interest. The faunal assemblage is comprised of 484 small fragmentary pieces identifiable only as medium ungulate and 213 identifiable pronghorn remains. Most of the assemblage was comprised of heavily butchered pronghorn bone, including numerous spirally fractured limb elements. In addition, the faunal material was thermally-altered, both burned and calcined, and contained bones with fine cutmarks and carnivore gnawing. One of the bone fragments also exhibited acid etching caused by carnivore digestion. A minimum of three adult pronghorn are represented; this MNI is based on 3 right unciform. Given the heavy degree of butchering, the actual MNI could be much larger if a larger sample were

obtained (Landals and Tischer 2001:262). Refer to Figure 6.3 for generalized skeletal diagram indicating faunal elements recovered at Stone Circle 25.

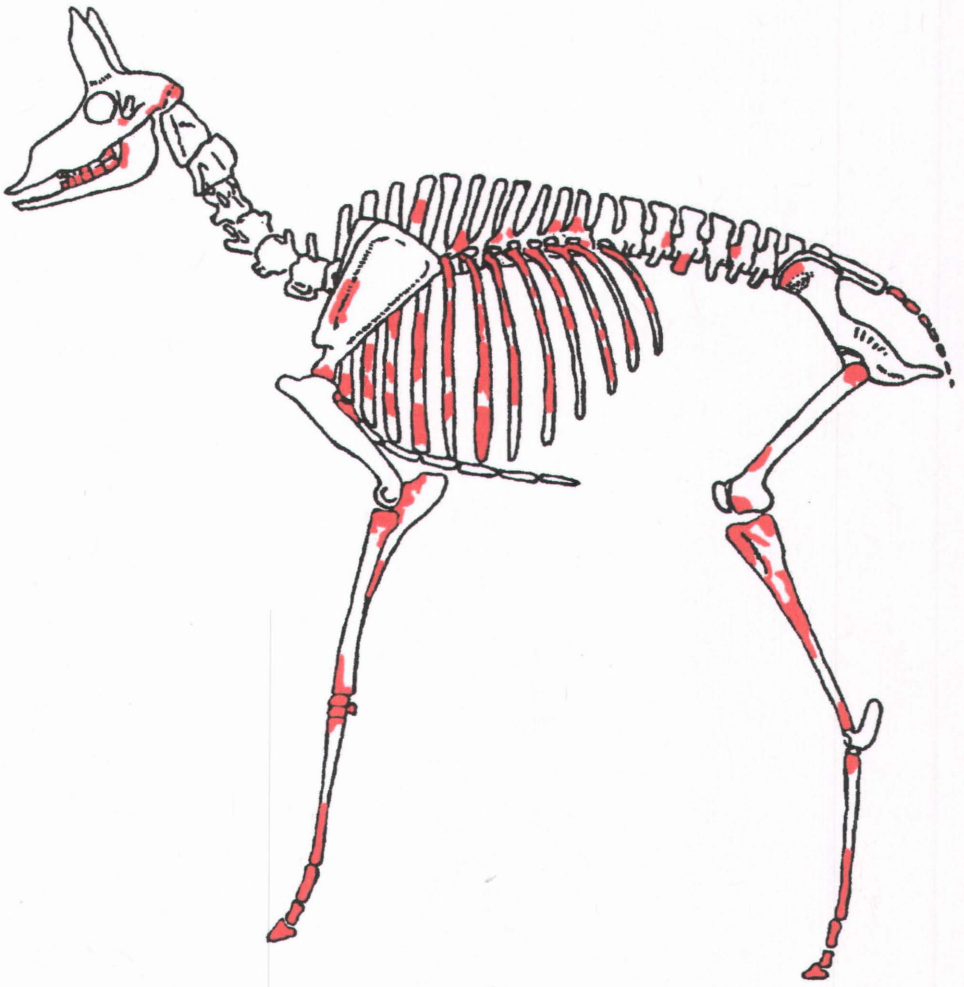


Figure 6.3 Generalized skeleton of a pronghorn showing skeletal portions recovered at EbPi-75, Stone Circle 25 (adapted from figure 8 in Davis et al. 2000:63)

Stone Feature 18 in the southern cluster was comprised of a small, eight rock cairn newly identified in 2000 (refer to Figure 3.7, Chapter 3). It is unclear if this feature relates to the earlier or later site occupation, but the cultural material was concentrated at a depth of 8 to 10 cm, suggesting it may be affiliated with the earlier period of site use.

Numerous high quality Montana Chert lithic flakes were recovered from the base of the feature. No charcoal or ash was noted among the cairn rocks, and only a small quantity of thermally-altered rock was recovered. However, the cairn proved surprisingly rich in terms of identifiable faunal material and the species represented is pronghorn (140 identifiable elements and 741 fragments classifiable only as medium ungulate). Elements represent at least one left and right forelimb and one hindlimb (Landals and Tischer 2001:251) (Figure 6.4). In addition, 9 of the faunal elements were spirally fractured, and 2 bones contained cutmarks. No carnivore gnawmarks or thermal alteration was observed on any of the Stone Feature 18 faunal material. One of the largest MNIs is from this feature, with a total value of 4, based on the right metatarsal, radial carpals, ulna, and ulnar carpals. This tally includes at least 4 adult animals. Refer to Figure 6.4 for a generalized skeletal diagram indicating faunal elements recovered at Stone Feature 18.

It is certain that any food resource once procured would be stored securely, safe from moisture and predation by domestic dogs or wild animals including raven and magpies (Nicholson 1985:178). In time, the contents of the cache, if not consumed by its owners, would spoil and eventually decay. In fact, none of the organics, except the bone, would survive for more than a few months on the surface unless the ground was frozen.

The association of cairns with other cultural features, such as tipi rings, may give archaeologists some indication of their use (Brink et al. 2003). In fact, numerous archaeologists have suggested that cairns were used as caches (Brink et al. 2003:214; Nicholson 1985).

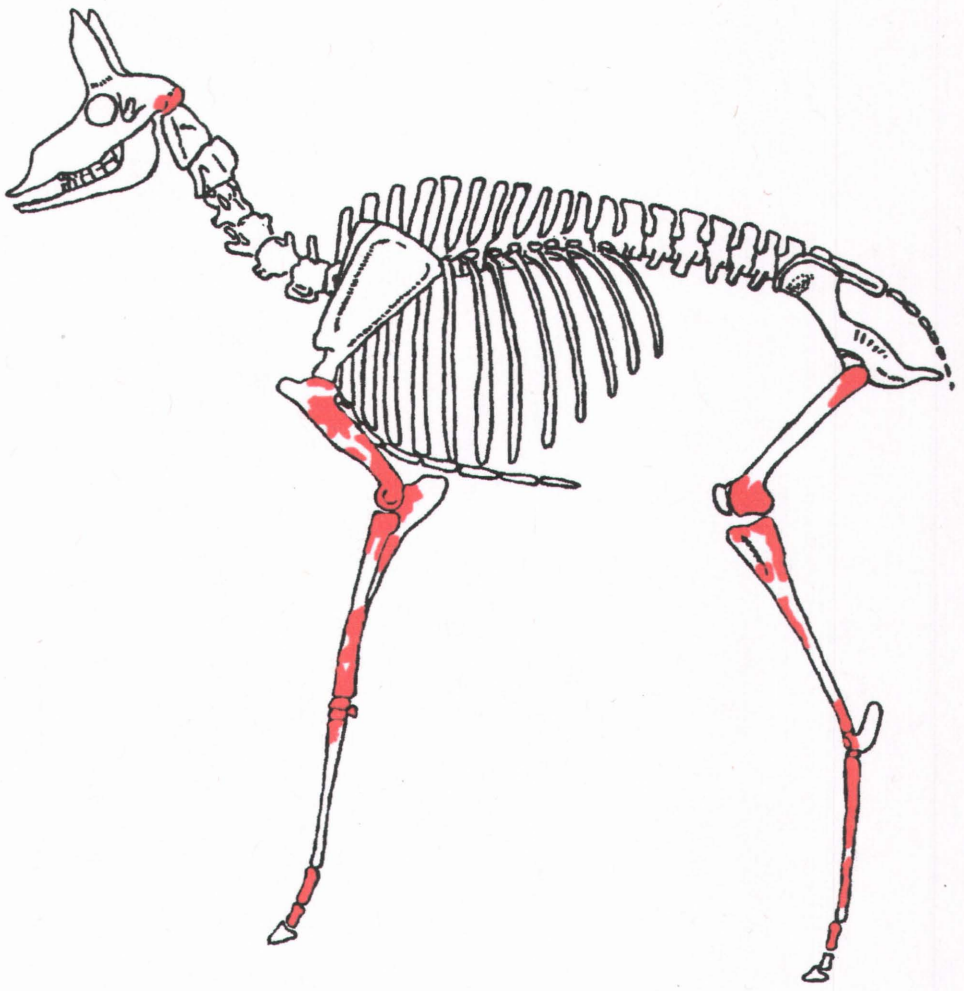


Figure 6.4 Generalized skeleton of a pronghorn showing skeletal portions recovered at EbPi-75, Stone Feature 18 (adapted from figure 8 in Davis et al. 2000:63)

Similar to the prehistoric cairn at DlLw-12 (Nicholson 1985), the feature at EbPi-75, referred to as Stone Feature 18, is most likely a meat cache. While there are no identifiable physical remains of the materials placed in the cache other than the stones overlaying the articulated and disarticulated pronghorn elements, the most probable contents would have been one or more unprocessed pronghorn butchering units perhaps wrapped in an untanned hide. In fact, at least one butchering unit consisted of the right

front limb of a pronghorn, the other elements represent the fragmented remains of a left front limb and left and right hind limb. Due to the size of the pronghorn the dismembered limbs or parts thereof could have been easily placed under a rock pile as a means of storage which offered some protection from domestic and wild animals.

Based on the above information pronghorn procurement may have served as a form of risk management. This is based on the fact that generally during the winter pronghorn would have remained more localized than bison and in larger herds than deer. Also, pronghorn, especially the females, retain their fat stores longer than the other Plains ungulates. This would have been recognized by northern Plains hunters and during the winter and early spring seasons the pronghorn may have been targeted for its supply of this essential nutrient. Caching would have simply been an insurance strategy to guarantee that scavengers, both wild and domestic did not consume the group's fat supply.

6.3.2 Discussion

Of the 25 separate loci at EbPi-75, four contained significant quantities of pronghorn remains; Stone Circles 1, 4, and 25, and Stone Feature 18. These remains were all recovered from spatially-discrete habitation structures rather than a continuous midden, with the exception of Stone Feature 18 which has been interpreted as a meat cache. These remains comprise the bulk of the faunal assemblage from Stone Features 1, 4, 25 and Stone Feature 18. Although only 758 pieces of bone are identifiable as pronghorn, it is believed that all of the medium-ungulate remains, which are shattered and highly fragmented, can also be attributed to this species, at these four loci.

A total of 3069, often fragmentary, pronghorn elements were recovered during the archaeological investigations at the site complex, the majority of specimens (29 %) coming from Stone Feature 18. Stone Circle 1 and Stone Circle 4 each contained 24 % of the assemblage, while Stone Circle 25 had 23 %. Appendix D contains a summary of all the specimens identified. This summary includes number and type of elements identified, and comments when appropriate. Based on the element frequency data it would appear that the procured pronghorn were transported intact to the habitation site and subsequently butchered, processed, and consumed.

The minimum number of individuals for each EbPi-75 locus containing significant pronghorn remains is summarized in Appendix D. One of the largest MNIs is from Stone Feature 18, with a total value of 4, based on the right metatarsal, radial carpals, ulna and ulnar carpals. This tally includes at least 4 adult animals. Stone Circle 1 had the other MNI value of 4, based on the left unciform, representing at least 4 adult individuals. The next smallest MNI value was represented at Stone Feature 25, with an MNI of 3, based on the right unciform; therefore at least 3 adult pronghorn are represented. The final MNI is from Stone Circle 4, with a total value of 2, based on the right distal tibia and left radial carpal. This value represents 2 adult individuals. These MNI values might have been higher if the fragmentation of most of the bones had not been so complete.

The pronghorn remains recovered from another loci (Stone Circle 9) consist of an isolated specimen, a single complete right astragalus, representing a single adult pronghorn. Perhaps the most striking thing about the pronghorn remains from EbPi-75 is the condition of the bone. At Stone Circle 4, for example, less than 6 % of the bone is diagnostic to the species level of classification *Antilocapra americana*, the remainder

identifiable only to the taxonomic level of order (Artiodactyla). This pattern (17 %, 6 %, and 8 %) is apparent in the other 3 loci, from EbPi-75, which contained significant pronghorn faunal assemblages. Typically, the samples were heavily comminuted and splintered. Similarities can be seen between the condition of this faunal assemblage and those of other small-scale pronghorn procurement sites such as Oyster Ridge (48UT35) (Zier 1982), Sun River (24CA74) (Greiser et al. 1985), Austin Wash (48UT390) (Lubinski 1997), Cactus Flower (EbOp-16) (Brumley 1975), and Blakiston (DjPm-115) (Dau 1990). Also, as is common at the above mentioned sites, few bone specimens bear evidence of cut marks (n = 18) from butchering, probably due in large part to the smashing of nearly all the ones that would exhibit these marks. Worth noting is the relatively high number (n = 48) of identified spiral fractures, which substantiate the interpretation that one of the activities being carried out at EbPi-75 was pronghorn marrow processing.

Grease extraction from bone is an important part of faunal processing (Leechman 1951; Frison 1971b; Binford 1978) and is often discussed by faunal analysts (see Chapter 5). This process involves crushing the bone to maximize surface area and maximize extraction of bone grease and marrow. This usually involved smashing the long bones, skull elements, and pelves with a cobble or chopper on an anvil stone. Being located next to Mosquito Creek, literally hundreds of river cobbles would have been available for this task.

The large number of phalanges (n = 81), either whole or fragmented, may be due to their small size, bone density, and lack of marrow. The large limb elements have a greater chance of being broken beyond recognition during the processes of marrow extraction and possible grease production. Only a little under half (48 %) of the

phalanges are broken and it seems unlikely that they are present because of deliberate selection for marrow or grease; therefore they were most likely schlepped in with the carcass. The "schlepp effect," as presented by Perkins and Daly (1968) and earlier by White (1952), predicts that long distances to camp or large prey size may prevent complete carcass recovery. This is clearly not the case at EbPi-75, but Binford's (1978) definition presents a more plausible scenario for the archaeological data. Binford (1978) explains the "schlepp effect" as a fortuitous association with the animal as a whole, where the element is simply brought back to the campsite with the rest of the carcass.

An interesting note is that the older sites such as Cactus Flower (Brumley 1975) and the Sun River Site (Greiser et al. 1985) exhibit a pattern of pronghorn bone fragmentation similar to that of the Late Prehistoric and Protohistoric pronghorn assemblages. This suggests a technology of bone processing that was established early in prehistory and was carried over into the contact period.

Butchering patterns at these site loci are less clear than at communal kill sites such as Eden-Farson (48SW304) (Frison 1971b) where there is a much larger sample of bone. Evidence useful in reconstructing butchering patterns includes: (1) the number and type of elements preserved, and (2) actual butchering marks left on the bone itself. Since the butchering loci was located within or just outside the campsite (see Chapter 5) there is no reason to believe that another separate butchering loci should exist, although some preliminary field butchering may have taken place at the point where the animal dropped after it was killed. All elements are represented in the sample, with long bone fragments (n = 675) and unidentified scrap (n = 1658) comprising the majority of the pronghorn faunal assemblage (76 %). Limb elements (n = 403) outnumber axial elements (n = 378) and represent 13 % of the identifiable elements, as compared to 12 % for the axial

elements. It must be noted that the ratio of elements may be the result of differential preservation rather than the act of butchering (see Chapter 5).

Kill sites generally have more elements of the axial skeleton (eg. skull and vertebral column), while processing sites have more limb elements. Due to the fact that this faunal assemblage contains both axial and appendicular elements, in a near equal split, while the entire range of element types represented supports a different hypothesis. This faunal assemblage lends support for the hypothesis that during small-scale pronghorn procurement the animals are killed out on the Plains and brought back to the campsite intact for primary butchering (see Chapter 5).

The archaeological data recovered from EbPi-75, Stone Circles 1, 4, 9 and 25, plus Stone Feature 18, synthesize well with the small-scale pronghorn procurement model that is being formulated in this research. Unfortunately, there were no identifiable pronghorn bones large enough to be sexed, and no fetal bone was recovered. The latter may have been present, but given the pulverized condition of the bone, it simply could have been unidentifiable (Landals, personal communication 2005). Therefore, no discussion regarding herd composition or prey preference is possible for this assemblage.

6.4 Bow Island Site (DlOu-72)

Within the context of this thesis, research involving DlOu-72 will focus on the zooarchaeological material uncovered from Component 1 and 2 (refer to Figure 3.5, Chapter 3), with particular attention being paid to the pronghorn antelope (*Antilocapra americana*) remains. These remains have undergone cleaning, conservation, cataloging and initial classification by the Bison Historical Services Ltd. staff in their Calgary laboratory facilities.

6.4.1 Pronghorn Faunal Assemblage

Faunal materials represent the majority of the cultural assemblage recovered from the DlOu-72 excavations (Goldsmith 2003:83). This material was collected, in greater or lesser quantities, from all five components at the site (Goldsmith 2003:83-84). While faunal materials at DlOu-72 represent a total of at least seven distinct species, the vast majority of the identifiable assemblage consists of pronghorn (15 %) and bison (80 %). A significant percentage of the more fragmented material in each component was categorized as medium ungulate, and on the basis of the complete absence of other "medium" ungulate species in the collection, is considered for analytical purposes to belong to pronghorn.

The faunal assemblage from Component 1 is comprised of 90 identifiable remains representing 5 species. These included; pronghorn (n = 40, 44.5 % of the identifiable total), bison (n = 45, 50.0 % of the identifiable total), beaver (n = 3, 3.3 % of the identifiable total), ground squirrel (n = 1, 1.1 % of the identifiable total), and fox (n = 1, 1.1 % of the identifiable total). The remainder of the materials is identifiable only to a more general taxonomic level and represents 1041 faunal fragments from the classes of medium ungulate, large ungulate, indeterminate ungulate, and mammal.

Identifiable pronghorn and medium ungulate specimens together number 106 or 9.4 % of the Component 1 faunal assemblage total. Of this total, 58 specimens (55 %) are catalogued simply as long bone fragments. The elements identified represent a broad range of skeletal portions (Figure 6.5), including axial skeleton, and front and rear hindlimb. Axial elements (skull, mandible, vertebrae and ribs) were poorly represented. The skull is represented by 6 tooth fragments, and ribs by 7 small fragments. Five vertebral elements were excavated, including two cervical, two thoracic, and one

lumbar; however, all are represented merely by articulating facet fragments. Density-mediated attrition, as well as other pre - and post-depositional factors, as discussed in Chapter 5 are the probable cause for this lack of skeletal representation.

The front and hind limb is represented by upper limb, carpal and tarsal elements, and several metatarsal fragments. Scapula and humerus are represented by one and three fragmented specimens of bone respectively. Carpal specimens include a right radial carpal and intermediate carpal. The tarsals include a left calcaneum and navicular cuboid.

Phalanges are represented in relatively large numbers as compared to the other limb elements. Two left proximal phalanges, eight medial phalanges (6 left and 2 right) and 10 terminal phalanges (6 left and 4 right) are present in the Component 1 faunal assemblage.

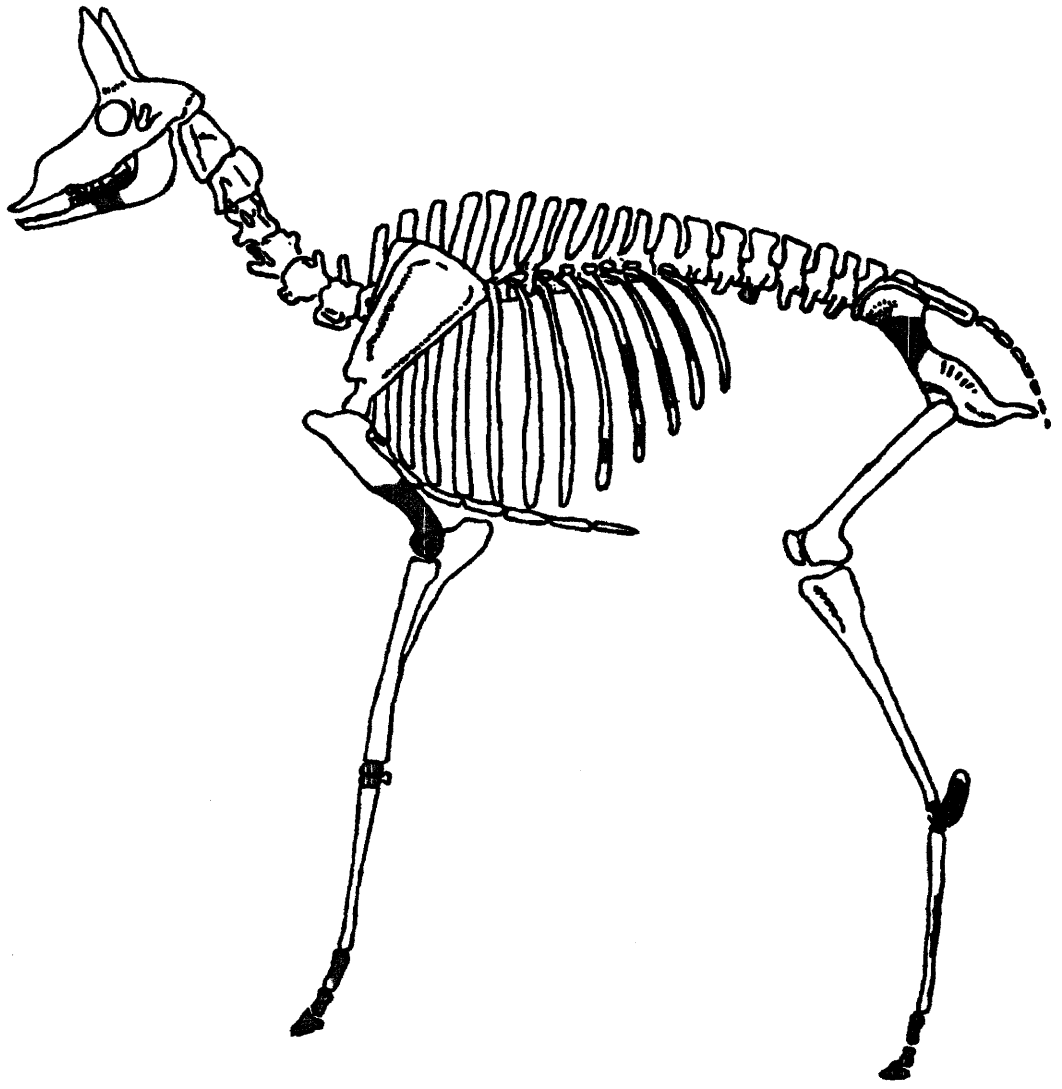


Figure 6.5 Generalized skeleton of a pronghorn showing skeletal portions recovered at DlOu-72, Component 1 (adapted from figure 8 in Davis et al. 2000:63)

The minimum number of pronghorn individuals tabulated from the faunal remains in Component 1 is simply based on sided-element counts. A minimum of two pronghorn individuals was assessed for Component 1, based on the presence of two left distal humeri.

In general the heavily fragmented pronghorn assemblage indicates the processing of the fauna for nutrients. Evidence includes the large quantity of reduced shaft fragments, especially the metapodials, supporting an argument for the campsite activity of marrow extraction

Taphonomic alterations of the pronghorn assemblage in Component 1 includes spiral fractures (n = 5), burning (n = 16), and carnivore gnawing (n = 2). The first two of these types of taphonomy are reflective of cultural activities conducted during the butchering and secondary processing of pronghorn for food. However, the relatively large number of burned fragments, as compared to all other components, may actually reflect a post-occupational process (Goldsmith 2003:85). "The paleosol in this component is characterized by a site-wide blackened appearance, as if the terrain across the entire terrace had been scorched by fire. It is proposed here that faunal materials on the surface of the ground at the time of the burning (perhaps a natural event) may likewise have been burned" (Goldsmith 2003:85). Gnawing, represented only minimally here, is probably reflective of post-occupational scavenging by opportunistic carnivores.

The faunal assemblage from Component 2 is comprised of 165 identifiable remains representing 5 species. These included pronghorn (n = 89, 54.0 % of the identifiable total), bison (n = 72, 44.0 % of the identifiable total), wapiti (n = 1, 0.5 % of the identifiable total), ground squirrel (n = 1, 0.5 % of the identifiable total), and an undetermined canid species (n = 2, 1.0 % of the identifiable total). The remainder of the materials is identifiable only to a more general taxonomic level and represents 2434 faunal fragments from the classes of medium ungulate, large ungulate, indeterminate ungulate, and mammal.

Identifiable pronghorn and medium ungulate specimens together number 223 or 8.6 % of the Component 2 faunal assemblage. Of this total, 93 specimens (41 %) are catalogued simply as long bone fragments. The elements identified represent a marked range of skeletal portions (Figure 6.6), including axial skeleton, and front and rear hindlimb. Axial elements (skull, mandible, and ribs) were reasonably well represented. The skull is represented by 1 crania fragment, 10 mandible fragments (9 body portions, 4 identifiable to side) and 4 tooth fragments (1 a left tooth fragment), and ribs by 29 fragmented medial portions (8 identifiable to side). No vertebral elements were identified, however, 2 left innominate fragments (1 acetabulum and 1 ilium fragment) were present. Density-mediated attrition, as well as other pre and post-depositional factors, as discussed in Chapter 5, are the probable cause of this lack of vertebral representation, although a sampling error may also be present.

In Component 2, the front limb is represented by upper limb, carpal and metacarpal fragments, while the hind limb is represented entirely by lower limb elements. Front upper limb element evidence consists of 2 right and a left humerus fragment. The radius is represented by 5 fragments consisting of 2 proximal right, a proximal left, a distal right and a indeterminate mid- shaft fragment. The scapula is is represented 3 fragmented specimens of bone. Carpal specimens include 2 left radial carpals, an intermediate carpal, a left unciform, left magnum, left accessory carpal and 2 indeterminate sesamoids.

The hind limb is represented by even fewer upper limb elements than the front limb. In fact, the femur is absent from the assemblage and the tibia is represented by only 2 left distal segments and a mid-shaft fragment. A single left patella was also recovered. The tarsals include a left astragalus and a left and right calcanei, a left cuneiform pes, 3

left lateral malleoli, and a left navicular cuboid. Six metatarsal fragments (1 left) along with 6 indeterminate metapodial fragments, represent the final long bones associated with this assemblage.

Phalanges are represented in comparable numbers to the other front and hind lower limb elements. Four left and one right proximal phalanx, 9 medial phalanges (5 left and 4 right) and 8 terminal phalanges (4 left and 4 right).

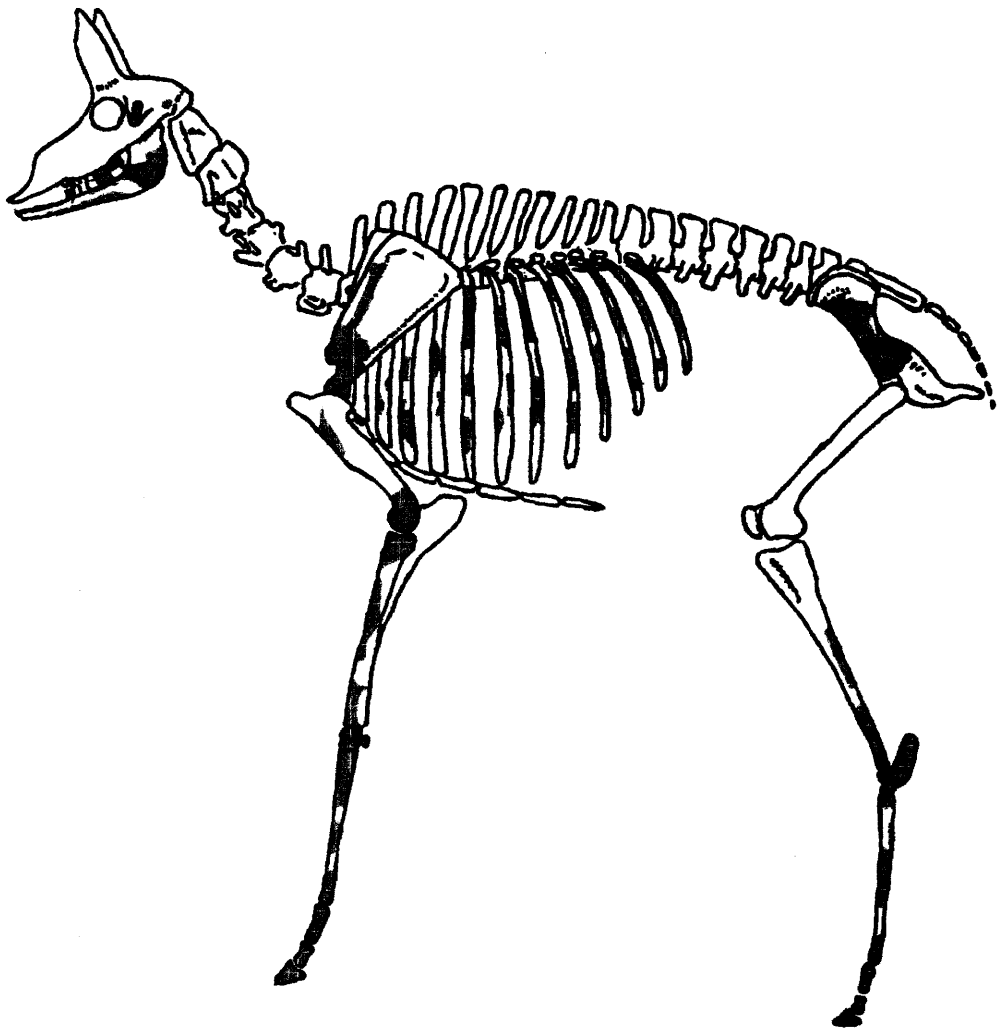


Figure 6.6 Generalized skeleton of a pronghorn showing skeletal portions recovered at DlOu-72, Component 2 (adapted from figure 8 in Davis et al. 2000:63)

The minimum number of pronghorn individuals tabulated from the faunal remains in Component 2 is simply based on sided-element counts and on comparison of mature and immature specimens. A minimum of three pronghorn individuals was assessed for Component 2, based on the presence of three left lateral malleoli, and on the presence of one juvenile and two mature left distal metacarpals.

In general the heavily fragmented pronghorn assemblage indicates processing for nutrients. Evidence includes the large quantity of reduced shaft fragments, especially the metapodials, supporting an argument for the campsite activity of marrow extraction. Taphonomic alterations of the pronghorn assemblage in Component 2 includes cutmarks (n = 3), spiral fractures (n = 36), burning (n = 3), and carnivore gnawing (n = 5). The first two of these types of taphonomy are reflective of cultural activities conducted during the butchering and secondary processing of pronghorn for food. In fact, the cut-marked ribs in this faunal assemblage were likely butchered using a metal tool (Goldsmith 2003:93-94) Carnivore gnawing, represented only minimally here, is probably reflective of post-occupational scavenging by opportunistic carnivores.

6.4.2 Discussion

Analysis of butchering marks and fragmentation patterns of bones suggest carcasses were disarticulated by cutting through joints, and bones were subsequently defleshed and broken for marrow extraction. Pronghorn average approximately 43 kg (live weight), and, as shown in Chapter 4, could be carried for moderate distances by a single hunter. It seems reasonable, therefore, to suppose that virtually complete carcasses were brought back to the site for butchering, processing and consumption. If this was in fact the case, then the elements recovered should correlate with the elements in a complete pronghorn skeleton.

However, this is not the case with the Component 1 and 2 pronghorn assemblages. In these cases less dense elements are absent from the assemblages. Therefore, a positive correlation with bulk density is expected. If bone density correlates highly with the survivorship of fossil classes, then differential survivorship of elements might be a factor in assemblage composition. However, this is not the entire picture as the bones are highly fragmented, most likely due to marrow extraction. Therefore, both cultural processes and the destruction of elements with low bulk densities have contributed to the archaeological composition of the DlOu-72 pronghorn faunal assemblages. The faunal assemblages associated with DlOu-72 support this hypothesis.

In addition, certain significant shifts are noticeable in the material assemblage from the bottom component (Component 5) to the top (Component 1). The greatest shift appears to be in faunal resource procurement preference, from a predominately bison assemblage in component 5, to one that favours pronghorn in the upper layers (Goldsmith 2003). It is suggested that this shift may be the hallmark of the fundamental cultural changes that were taking place within the northern Plains native populations on the cusp of European entrance into the region (Goldsmith 2003:153). The rapid and almost complete extermination of the bison populations as a result of over hunting in the 18th and 19th centuries removed a traditional prey choice from the Native diet, and it is possible that the changing faunal assemblage of DlOu-72 is a refection of that process (Goldsmith 2003:153).

6.5 Conclusions

The examination of ancient human food refuse provides a means by which prehistorians can gain meaningful insights into the multi-faceted nature of human behaviour. By studying the osseous remains from archaeological sites, one can often

glean insight into the methods of faunal resource procurement and processing, practiced by its occupants.

Due to the combined effects of butchering, transport, marrow extraction, bone grease manufacture and carnivore attrition often reduce the larger anatomical parts to fragments it is often difficult to analyze heavily processed assemblages with the methods developed thus far. Even with this methodological problem the faunal remains from EbPi-75, Stone Circle 1, 4, 25 and Stone Feature 18, along with those from DlOu-72, still provide comprehensive evidence of small-scale pronghorn procurement and its association with campsites on the northern Plains. Not only is it apparent that pronghorn were utilized in the Late Precontact period on the northern Plains, but there is evidence that this species was part of a risk management subsistence strategy involving resource caching and processing for bone grease and marrow. The evidence presented above supports the hypothesis that northern Plains archaeological sites containing pronghorn remains present a palimpsest of evidence for the small-scale procurement of *Antilocapra americana*.

In addition, the lack of animal age estimates available for single and small-scale kill sites hinders the analytic process. This type of data would have provided an important baseline for comparison with age structures at larger communal kill sites in the United States. This would also have helped to avoid theoretical assumptions about the differences between small-scale and mass kill strategies, as demonstrated by Lubinski (1997).

CHAPTER SEVEN

Summary and Conclusions

7.1 Summary

Due to the broad scope of this thesis, the task of summarization is best broken into two parts. Part one will address the evidence presented in the previous chapters arguing for the small-scale procurement of pronghorn on the northern Plains. The second part, while relevant to the above hypothesis, will address the issue of scarcity of pronghorn remains in the archaeological record, their seemingly exclusive occurrence at habitation sites, and the lack of archaeological evidence with regard to pronghorn kill sites on the northern Plains.

Evidence presented in Chapters 3 and 4 clearly indicates that pronghorn procurement, based on a broad spectrum of hunting techniques, was a standard component of aboriginal subsistence on the northern Plains. The information presented in this thesis reflects a clear reliance on a small-scale hunting strategy for the procurement of pronghorn. To say that the people of the Plains only utilized pronghorn as a secondary food source is to greatly oversimplify the situation. However, the available data support "the notion that pronghorns were a regularly selected secondary prey, sometimes taken individually or in small numbers, but very seldom selected as focal prey on a communal scale by Prehistoric bison hunters" (Davis and Fisher 1988:113). The greatest problem in making these kind of determinations is the one of differential preservation of

archaeological materials in sites. Bison bones are quite obvious and preserve relatively well but the remains of smaller animals are less well preserved.

Differences between the exploitation of pronghorn and other species may be somewhat exaggerated. Due in part to nuances in sampling and investigation history, pronghorn use in the study area remains fundamentally different from the exploitation of bison because it appears to be only an occasional resource supplement rather than the primary staple upon which subsistence scheduling, social movements, and even survival itself depended. Examination of the archaeological literature does indicate much about northern Plains pronghorn subsistence patterns, but not on the same scale as for bison. Bison clearly were a major focus of subsistence efforts, based on their prominence in regional archaeofaunas and the presence of classic mass kill sites. However, pronghorn and other secondary faunal resources also played significant roles throughout northern Plains prehistory.

The bison-focal model is an accurate and powerful model of Plains lifeway, on a coarse scale, but can be interpreted in such a way as to ignore or obscure potentially significant variation in time and space within the broad pattern. In other words, there is a danger of being trapped into viewing all of prehistory as merely variations on a single theme. In an attempt to readdress this problem, an examination of pronghorn procurement on the northern Plains was undertaken. Whether the pronghorn procurement strategy shown here is viewed by others as significant is in some ways less important than the attempt to examine variability rather than assuming resource uniformity for northern Plains hunter-gatherers.

This research has resulted in the recognition of a small-scale hunting sequence of events. Initially, the hunter leaves camp to procure an ungulate from the surrounding

prairie ecozone. The animal or animals must be located; due to the fact that bison and pronghorn fed symbiotically, these two species could often be found together. If given the chance a bison would be the primary prey species. However, this would only be the case if bison were found before the hunter encountered a pronghorn. Also, if a pronghorn was needed for a specific purpose (e.g. hides for clothing) or no bison were in the area due to their seasonal round, then a pronghorn would be the species taken on the northern Plains.

As the archaeological, ethnographical and historical records indicate, pronghorn provided a readily available supply of meat, often in large quantities, along with good quality hides and the raw materials needed for bone tools. Pronghorn were hunted using a variety of techniques ranging from the ambush of an individual animal to a large-scale communal trap. Each cultural group procured and utilized the pronghorn in unique ways.

Based on the evidence provided in this thesis there may in fact exist another distinct cultural tradition with regard to pronghorn procurement. Unique pronghorn hunting strategies are know to have been utilized by culture groups living in the High Plains, Great Basin and now the northern Plains. In fact, there is a clear north/south dichotomy with regards to pronghorn procurement strategies. Within the Great Basin communal hunting was the predominant hunting method. On the High Plains of Wyoming, and into parts of North and South Dakota, as well as Montana, a mixture of communal and small-scale procurement is evident. With regards to the northern Plains small-scale procurement is the dominant strategy utilized by northern Plains groups to procure pronghorn.

The conclusions drawn by this thesis indicate that the culture groups procuring pronghorn on the northern Plains utilized distinct strategies based on the specific

behaviour and topography of the region. Archaeologists are often reluctant to utilize animal behaviour studies or the direct experiences of hunting for analyzing past hunting methods and the limitations imposed by prey species. One use for the type of information provided in Chapter 2 is the identification of geographic bottlenecks located along pronghorn migration routes. These localities should provide the opportunity to search for additional archaeological sites that may have coincided with the interception of herds at different points along their travel routes. If such sites were discovered and if they contain well-preserved faunal remains, then additional details on the antiquity, continuity, and location of prehistoric pronghorn procurement activities on the northern Plains could be recovered. This correlation of the zooarchaeological evidence and migration route data suggests predictions of prehistoric site locations relating to pronghorn procurement. Through a comprehensive understanding of both animal biology and ecology better interpretations of prehistoric procurement situations may be realized. In addition, the ethological information has demonstrated how susceptible the pronghorn is to small scale-scale hunting strategies. This fact was further quantified through the use of an optimal foraging theory based efficiency index.

The knowledge of habitat and nutritional requirements along with home range and physiology, provided in Chapter 2, all would have been information important to the aboriginal hunter pursuing the pronghorn. For the archaeologist these data simply aid in the understanding of the prey species and assist in isolating areas that have a high potential to contain sites linked to the small-scale procurement of pronghorn.

The review of sites containing pronghorn remains (Chapter 3) provides for a regional comparison between communal and non-communal pronghorn procurement in the archaeological record. The presence of these sites further strengthens the argument

against the mass kill strategy of pronghorn procurement as the norm on the northern Plains. While evidence for both communal and non-communal pronghorn hunting strategies are provided for Wyoming, this inclusive evidential database simply is not available for the northern Plains. The small herd sizes of northern Plains pronghorn when compared to those from Wyoming also make it likely that small-scale procurement was a more effective hunting strategy. Also, topography, like that found in Wyoming, which would have acted as a natural barrier to funnel pronghorn herds into an entrapment complex, is limited on the northern Plains. Most evidence for pronghorn procurement and utilization is similar to that encountered at Cactus Flower, a small number of pronghorn faunal elements found in relation to large quantities of bison material. Such materials may generally reflect the same pattern of cultural utilization inferred by small-scale procurement.

If a pattern of increasing use of mass procurement techniques relative to small-scale hunting strategies signals resource intensification as proposed by Lubinski (1997), then there is evidence for pronghorn intensification in the Green River Basin area of Wyoming. However, on the northern Plains we do not see this trend archaeologically. The proportion of mass kills to single/small-scale kills does not increase. Instead we see an intensification through time in the frequency of sites utilizing small-scale hunting as a pronghorn procurement strategy. This patterning is based on the chronological distribution of sites and on the method of procurement (communal or non-communal) utilized at those sites, and begs for an explanation. Why should pronghorn 'suddenly' become more frequently utilized as a resource during the Late Prehistoric/Protohistoric period?

In addition to the lack of communal hunting evidence on the northern Plains another line of evidence supporting small-scale procurement on the northern Plains is also provided in Chapter 4. This is the introduction of a procurement technology, in the form of the bow and arrow, that is perfectly suited to the stealthy movements need to successfully stalk, ambush or intercept a pronghorn. The existence of this technology may also provide a partial explanation for the greater occurrence of habitation sites containing pronghorn remains in the Late Prehistoric.

So why are pronghorn under represented in the archaeological record of the northern Plains? First, pronghorn behaviour makes their procurement more difficult than bison; however, they still represent a desirable prey species. This is seen in terms of their efficiency index, as discussed in Chapter 4. Pronghorn habitat, combined with the topographic variable, makes small-scale hunting strategies more viable, especially when compared to the communal procurement of bison. Small-scale hunting leaves a minimal archaeological signature, especially in terms of artifacts, features and concentrated bone assemblages found at kill sites. As well, poor bone survivorship may be responsible for the archaeological invisibility of earlier pronghorn procurement evidence.

Based on the archaeological, ethnographic and historic evidence from the northern Plains it would seem that pronghorn procurement in this region was practiced on a small-scale by individual or small groups of hunters. These hunters would field-dress their kills and then bring them back to the campsite for final processing. This scenario accounts, in part, for the enduring lack of pronghorn kill sites on the northern Plains and the abundance of pronghorn remains recovered from archaeological campsites. These remains are often heavily processed indicating that they were being procured for reasons

other than their skins and may, in fact, have been used at times to ward off seasonally related nutritional stress.

This line of thinking brings us to the second part of this thesis which addresses the presence of small quantities of pronghorn remains at numerous sites and the lack of pronghorn kill sites on the northern Plains (Chapter 5). It was found that essentially all of the northern Plains archaeological sites containing pronghorn remains conform to a pattern indicative of a terminal processing and consumption site. In fact a detailed study of a number of lines of evidence from numerous northern Plains archaeological sites indicated that none of them were pronghorn kill sites. The obvious exception to this is the Laidlaw Antelope Trap (Brumley 1983, 1984) which is a communal pronghorn kill site. However, the Laidlaw site is an anomaly and certainly not the norm with regard to northern Plains pronghorn procurement. In fact, the author is aware of only two-well documented archaeological examples of communal pronghorn procurement on the Plains north of Wyoming. Davis (1976) and Frison (1971b) both infer communal pronghorn procurement is not typical of aboriginal subsistence strategies on the Plains. However, based on the evidence recovered at the Laidlaw site, Brumley (1983, 1984) argues that it is a typical northern Plains procurement strategy. The general lack of extant hunting facilities such as pronghorn traps and corrals seem to refute this statement. Even if such complexes were perishable, as the structures found in the Wyoming Basin are, some evidence would surely have been recovered by archaeologists.

The absence of kill sites or temporary hunting camps is additional evidence that pronghorn hunting was not a strategy designed to accumulate abundant stores of preserved food, as is common in communal hunting. In fact, the evidence based on

faunal assemblage patterns and site content seems to indicate that the reason for procuring pronghorn on the northern Plains was to provide meat and other animal products for immediate consumption. This does not, however, discount the argument that pronghorn were procured, in some instances, as part of a risk management strategy. This strategy simply places the pronghorn in the augmentative role of providing seasonal variety and a dietary supplement during times of absence or nutritional stress in bison.

The above evidence has further relevance to small-scale procurement in that the pronghorn is small enough that the carcasses could be simply carried away from the kill site intact. This method of procurement, processing and transportation produces a very ephemeral archaeological record. In addition, small-scale procurement by its very nature provides a number of sites with limited quantities of artifacts rather than the single large quantity associated with communal procurement.

This hypothesis is further explored through examining the various cultural and non-cultural taphonomic effects that are responsible for this patterning seen in the archaeological record. Non-cultural agents include the reduction of the archaeological pronghorn signature by carnivore attrition, weathering and trampling. In addition, the cultural processes of field butchering, secondary processing and consumption further reduce the quantities of pronghorn remains that remain to be recovered.

The fact that pronghorn are most likely to be killed on the prairie proper, rather than in a river valley or coulee, also contributes to the lack of archaeological visibility. Low preservation conditions abound, soil deposition is not as rapid as the flooding of river terraces. This in-turn allows for a high incidence of carnivore attrition and trampling, in addition to rapid deterioration of bone due to weathering.

Another fact that must be considered is that no real butchering or processing takes place at the kill site. The pronghorn is field butchered then transported whole to the campsite for secondary butchering and processing. This leaves little in the way of an archaeological signature to identify where the pronghorn was killed. In addition, the low bone density of pronghorn elements contributes to poor survivorship of selected elements, which in turn skews the archaeological record.

When deposited at a campsite, pronghorn elements are also susceptible to carnivore attrition and trampling. Archaeologically this can often be seen through the presence of features such as meat caches made of river cobbles, used to protect various butchering units from predation. In addition, butchering, and processing, especially for the utilization of marrow and grease, all reduce the survivorship and hence the visibility of pronghorn in the archaeological record. Finally, the division or parceling of a pronghorn carcass would further reduce the archaeological signature by spreading the remains over a larger area. This reduction hypothesis was then quantified in Chapter 5 using the paired t-test. This confirmed that there is a correlation between bone density and the elements that are recovered archaeologically.

Finally, in Chapter 6 two recently excavated northern Plains pronghorn assemblages from EbPi-75 and DlOu-72 were analyzed and compared to the existing body of research. The conclusions drawn from this analysis indicate that both of these sites provide a case for the small-scale procurement of pronghorn on the northern Plains.

Examining all the evidence presented here provides a clear indication that pronghorn procurement, based on a broad spectrum of hunting techniques, was a standard component of aboriginal subsistence strategies on the northern Plains. Throughout this thesis, evidence has been provided in order to build a series of comprehensive models of

northern Plains pronghorn procurement. Whereas this research represents only an initial framework, it still provides considerable insight into the complex interrelationships between the various components of hunter-gatherer subsistence strategies.

7.2 Suggestions for Future Research

This thesis may assist in the modeling of the landscape as it relates to the small-scale pronghorn procurement. Through the identification of potential topographic features that would be required in order to successfully procure pronghorn. As this research has indicated, prehistoric migration routes would have been predictable locations for the small-scale procurement of pronghorn, especially during late winter and early spring. Therefore, these routes represent high potential areas in which to conduct archaeological surveys aimed at the acquisition of additional data relevant to the small-scale procurement of pronghorn. By locating additional pronghorn remains the augmentation and expansion of the current knowledge base with regards to small-scale procurement will result.

As stated above, the real value of this research is in its application as a framework for the further recovery and interpretation of pronghorn remains within the context of Plains archaeology. It is the hope of the author that this thesis may provide some of the background research and references needed by a zooarchaeologist undertaking the analysis of a northern Plains archaeological site rich in pronghorn remains.

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APPENDIX A

Ecological Regions Map

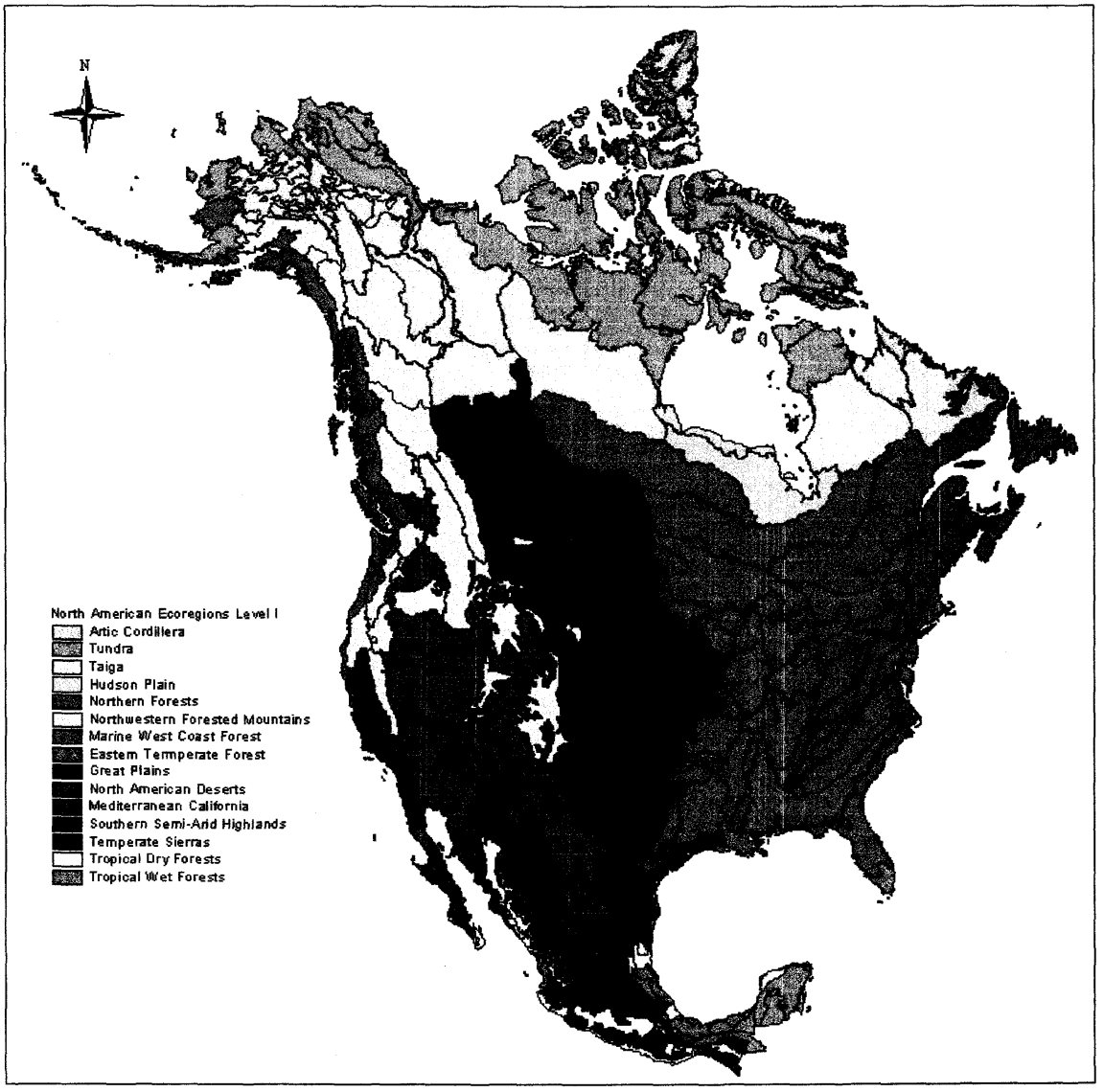

Figure A.1 Level 1 ecological regions of North America

APPENDIX B

Condensed Archaeological Site Data

Site Name & No.	State or Prov.	Site Type	Date B.P. (Approx.)	Culture Group	Season of Occupation	Pronghorn as a Resource	MNI	Small-Scale Hunting	Comments
Agate Basin, Sheaman Locality (48NA211)	WY	Campsite	10,100 ± 2800 to 10,140 ± 500	Paleoindian	Spring/Summer	Secondary	1	Yes	Pronghorn Bone Tool
Agate Basin (48NO201)	WY	Seasonal Campsite	11,840 ± 130 to 10,665 ± 85	Paleoindian	Unknown	Secondary	4/6 Total	Yes	Majority of Remains from Folsom Level
Austin Wash (48UT390)	WY	Processing Site	1250 ± 60 to 1140 ± 80	Late Prehistoric	Fall/Winter	Primary	18	Yes	
Boar's Tusk (48SW1373)	WY	Short-Term Campsite	100 ± 80	Late Prehistoric - Protohistoric	Mid Fall - Mid Winter	Primary	6	Yes	
Bridger Antelope Trap (48UT1)	WY	Trap Complex	Unknown	Late Prehistoric	Unknown	Primary	-	No	
Casper (48NA304)	WY	Parabolic Dune Bison Trap	~ 9500	Paleoindian	Late Fall	Secondary	1	Yes	
Eden-Farson (48SW304)	WY	Campsite	230 ± 100	Late Prehistoric - Protohistoric	Winter	Primary	212	No	
Firehole Basin 11 (48SW1217)	WY	Campsite	625 ± 50 to 345 ± 135	Late Prehistoric - Protohistoric	Winter	Primary	37	No	
Gailiun (48SU1156)	WY	Campsite	150 ± 60	Late Prehistoric - Protohistoric	Fall/Winter	Primary	8	Yes	
Glenrock Buffalo Jump (48CO304)	WY	Bison Jump	280 ± 100 to 210 ± 100	Late Prehistoric	Fall	Secondary	1	Yes ?	Pronghorn Bone Tool
Hawken (48CK303)	WY	Arroyo Bison Trap	6470 ± 140 to 6270 ± 140	Middle Archaic	Early/Mid Winter	Secondary	1	Yes	Pronghorn Bone Tool
Lightning Spring (39HN204)	SD	Campsite	4200 ± 170 to 4040 ± 90	Middle Archaic	Summer/Early Fall	Primary	8	No	

Table B.1 Condensed data from United States of America archaeological sites containing pronghorn remains

Table B.2 Condensed data from United States of America archaeological sites containing pronghorn remains

Site Name & No.	State or Prov.	Site Type	Date B.P. (Approx.)	Culture Group	Season of Occupation	Pronghorn as a Resource	MNI	Small-Scale Hunting	Comments
Little Missouri Antelope Trap (48CK49/69)	WY	Trap Complex	Unknown	Historic	Unknown	Primary	-	No	Kill Site for 39FA23 & 39FA83
Lost Terrace (24CH68)	MT	Processing Site	1190 ± 60 to 925 ± 80	Early Late Prehistoric	Winter	Primary	55	No	14 Fetal Pronghorn
Oyster Ridge (48UT35)	WY	Campsite	1375 ± 60	Late Prehistoric	Spring	Primary	4	Yes	1 Fetal Pronghorn
Pictograph Cave (24YL1)	MT	Rockshelter	Unknown	Middle Plains Archaic - Late Prehistoric	Unknown	Secondary	-	No	
Schiffer Cave (48JO319)	WY	Rockshelter	8500 ± 160 to 8360 ± 160	Paleoindian	Unknown	Secondary	1	Yes	
Sister's Hill (48JO314)	WY	Campsite	9650 ± 250	Paleoindian	Unknown	Primary	NA	Yes	
Skull Point (48LN317)	WY	Short-Term Campsite	1375 ± 55 to 300 ± 50	Late Prehistoric	Unknown	Secondary	>1	Yes	Midden
Sun River (24CA74)	MT	Campsite	5670 ± 190 to 3450 ± 350	Early Plains Archaic	Fall/Early Winter	Primary	4	Yes	Level VI-IV
Trapper's Point (48SU1006)	WY	Kill/Processing Site	7800 ± 60 to 2890 ± 60	Early Archaic	Spring	Primary	35	No	8 Fetal Pronghorn
39FA23	SD	Campsite	860 ± 90 to 600 ± 50	Late Prehistoric	Fall	Primary	21	No	Midden Bone Tool
39FA83	SD	Campsite	Unknown	Late Prehistoric	Unknown	Primary	48	No	
48SW270	WY	Campsite	1460 ± 90 to 1210 ± 90	Late Prehistoric	Late Spring/Late Fall	Secondary	3	Yes	Plus 1 Fetal Pronghorn

Table B.3 Condensed data from Canadian archaeological sites containing pronghorn remains

Site Name & No.	State or Prov.	Site Type	Date B.P. (Approx.)	Culture Group	Season of Occupation	Pronghorn as a Resource	MNI	Small-Scale Hunting	Comments
Blackiston (DjPm-115)	AB	Campsite	730 ±180 to 350 ± 100	Late Prehistoric - Historic	Winter/Spring	Secondary	-	Yes	48 Elements in 9 Levels
Boss Hill (FdPe-4)	AB	Campsite	2355 ± 70 to 1860 ± 55	Late Plains Archaic	Unknown	Secondary	1	Yes	
Bow Island (DlOu-72)	AB	Short-Term Campsite	180 ± 50 to 170 ± 50	Late Prehistoric - Protohistoric	Unknown	Primary	2/3	Yes	Component 1and 2
Cactus Flower (EbOp-16)	AB	Campsite	4220 ± 130 to 2130 ± 130	Late Plains Archaic	Winter/Spring	Secondary	6	Yes	
EbPc-10	AB	Campsite	~ 200	Late Prehistoric - Historic	Spring/Early Fall	Secondary	1	Yes	
Empress Tipi Ring Site (EfOo-130)	AB	Campsite	Unknown	Late Prehistoric	Unknown	Secondary	-	Yes	
Forty Mile Coulee (DjOu-62)	AB	Campsite	470 ± 70 to 250 ± 80	Late Prehistoric - Protohistoric	Spring/Summer	Secondary	10	Yes	10 pronghorn from 10 Locations / Features
Gowen I (FaNq-25)	SK	Camp/Processing Site	6150 ± 110 to 5670 ± 135	Early Middle Period	Late Summer/Early Fall	Secondary	1	Yes	Pronghorn Bone Tool

Table B.4 Condensed data from Canadian archaeological sites containing pronghorn remains

Site Name & No.	State or Prov.	Site Type	Date B.P. (Approx.)	Culture Group	Season of Occupation	Pronghorn as a Resource	MNI	Small-Scale Hunting	Comments
Heron Eden (EeOi-11)	SK	Bison Kill/Processing Site	9210 ± 110 to 8920 ± 130	Paleoindian	Winter	Secondary	1	Yes	
Laidlaw Antelope Trap (DlOu-9)	AB	Trap Complex	3420 ± 130	Late Plains Archaic	Unknown	Primary	-	No	
Larson (DlOn-3)	AB	Campsite	2480 ± 150 to 1140 ± 90	Late Prehistoric	Late Winter	Secondary	1	Yes	
Little Bow Reservior (EbPi-75)	AB	Campsite	~ 210 to 120	Late Prehistoric - Protohistoric	Spring	Secondary	4	Yes	Stone Circle 1
Newo Asiniak (FbNp-16)	SK	Bison Jump	185 ± 190	Late Prehistoric - Protohistoric	Mid Winter/Spring or Fall	Secondary	-	Yes ?	
Saamis (EaOp-6)	AB	Campsite	435 ± 125 to 85 ± 70	Late Prehistoric - Protohistoric	Late Winter/Early Spring	Secondary	3	Yes	
St. Mary Reservior (DhPg-8)	AB	Lithic Scatter	Unknown	Paleoindian?	Not Applicable	Not Applicable	N/A	N/A	Lithic Eccentrics
Writing-On-Stone Provincial Park	AB	Petroglyphs	Unknown	Unknown	Not Applicable	Not Applicable	N/A	N/A	Pronghorn Zoomorphs

APPENDIX C

Element Abbreviations Used in Faunal Assemblage Analysis

(Unfreed 1993:505-506)

Unidentified Bone

S = miscellaneous unidentified fragments ("scrap")
L = miscellaneous unidentified long bone fragments ("limb")

Identified Bone

Axial Elements

SK = skull
HY = hyoid
MA = mandible
ST = sternum
AT = atlas
AX = axis
CV = cervical vertebra
TV = thoracic vertebra
LV = lumbar vertebra
SV = sacral vertebra
CAV = caudal vertebra
IV = indeterminate vertebra
RI = rib
CC = costal cartilage
TO = tooth

Forelimb Elements

SC = scapula
HU = humerus
RA = radius
UL = ulna
MAG = magnum
RC = radial carpal (scaphoid)
UN = unciform carpal
UC = ulnar carpal (cuneiform)
INT = intermediate carpal (lunate)
AC = accessory carpal (pisiform)
MC = metacarpal
FM = fifth metacarpal
MAT = manus II
IC = indeterminate carpal

Hindlimb Elements

PE = pelvis
FE = femur
PA = patella
TI = tibia
FI = fibula
LM = lateral malleolus
AS = astragalus
CA = calcaneum
NC = navicular cuboid
CP = cuneiform pes
FT = first tarsal
MT = metatarsal
PT = pes III
PF = pes V
IT = indeterminate tarsal

Lower Limb Elements

PP = proximal phalange (P-1)
MP = medial phalange (P-2)
TP = terminal phalange (P-3)
IM = indeterminate metapodial
PS = proximal sesamoid
DS = distal sesamoid
IS = indeterminate sesamoid

APPENDIX D

Tables Containing Elements Recovered Data from DlOu-72

Element	NISP	Left	Right	Indet.	MNI
AX	1			1	1
CA	1	1			1
HU	3	2	1		2
INT	1		1		1
L	51			51	-
LV	1			1	1
MA	1			1	1
MP	8	6	2		2
MT	2	1		1	1
NC	1	1			1
PE	1	1			1
PP	2	2			1
PS	2			2	1
RC	1		1		1
RI	7	2		5	1
SC	1			1	1
TO	6	2	1	3	1
TP	10	6	4		1
TV	2			2	1
IS	2			2	1
CV	2			2	1
Total	106				

Table D.1 DlOu-72 Component 1 Pronghorn Assemblage

Element	NISP	Left	Right	Indet.	MNI
AS	1	1			1
AC	1	1			1
CA	2	1	1		1
CP	1	1			1
HU	3	2	1		2
IM	6			6	-
INT	1	1			1
L	93			92	-
LM	3	3			3
MA	10	2	2	6	2
MAG	1	1			1
MC	7	6	1		6
MP	9	5	4		1
MT	6	1		5	1
NC	1	1			1
PE	2	2			2
PP	5	4	1		1
RA	5	1	3	1	3
RC	2	2			2
RI	39	7	1	31	-
SC	4	1	1	2	1
SK	1			1	1
TI	3	2		1	2
TO	4	1		3	1
TP	8	4	4		1
UC	1	1			1
UN	1	1			1
IS	2			2	1
PA	1	1			1
Total	223				

Table D.2 DlOu-72 Component 2 Pronghorn Assemblage

Tables Containing Elements Recovered Data from EbPi-75

Element	NISP	Left	Right	Indet.	MNI
AS	7	2	3	2	3
CA	1		1		1
CP	2		2		2
HU	16	5	11		11
FE	15	4	8	3	8
FT	1			1	1
IC	1			1	1
IM	9			9	-
INT	8	6	2		6
L	206			206	-
MAG	3	1	2		2
MC	6	1	4	1	4
MP	1			1	1
MT	10	4	4	2	4
NC	2	1	1		1
PP	4			4	1
RA	14	9	3	2	9
RC	6	1	5		5
SK	3		1	2	-
TI	13	7	3	3	7
TP	1			1	1
UC	6	2	4		4
UL	7	3	4		4
UN	4	2	2		2
Total	346				

Table D.3 EbPi-75 Stone Feature 18 Pronghorn Assemblage

Element	NISP	Left	Right	Indet.	MNI
AS	5	3	2		3
AT	2	1	1		1
AX	1	1			1
CA	4	2	2		2
CC	1			1	1
CP	2	1	1		1
HU	8	2	5	1	5
FE	9	3	3	3	3
FT	2	1	1		1
IM	7			7	-
INT	3	2	1		2
L	186			186	-
LM	3	1	2		2
LV	3	3			1
MA	5		1	4	1
MAG	3	1	2		2
MC	6	3	3		3
MP	11	7	4		1
MT	11	6	2	3	6
NC	3	1	2		2
PE	6	2	4		4
PP	17	8	8	1	2
RA	6		5	1	5
RC	2	2			2
RI	11	1	6	4	1
SK	53	4		49	-
TI	16	3	10	3	10
TO	33	7	1	25	1
TP	6	4	2		1
TV	2			2	1
UC	2	2			2
UL	5	4	1		4
UN	4	2	2		2
IV	2			2	1
Total	440				

Table D.4 EbPi-75 Stone Circle 1 Pronghorn Assemblage

Element	NISP	Left	Right	Indet.	MNI
AC	1			1	1
CA	4	2	2		2
HU	3	3			3
FE	3		2	1	2
IM	1			1	1
L	114			114	-
MA	17	1		16	1
MC	2	1	1		1
MP	4	2	2		2
MT	5	2	1	2	2
PE	6	5	1		5
PP	6	3	3		1
PS	4			4	1
RA	1	1			1
RC	2	2			2
RI	6			6	1
SK	23	1		22	1
TI	5	3	2		3
TO	21	6	4	11	1
TP	5	2	3		1
IV	9			9	1
Total	242				

Table D.5 EbPi-75 Stone Circle 4 Pronghorn Assemblage

Element	NISP	Left	Right	Indet.	MNI
AS	1		1		1
AT	2			2	2
CAV	3			3	3
CC	1			1	1
FE	5	2	1	2	2
FI	1			1	1
INT	2	1	1		1
L	168		7	161	-
LV	2		1	1	1
MA	1	1			1
MAG	2		2		2
MC	6	2	3	1	3
MP	7	3	3	1	1
MT	6	4		2	4
PE	2	1		1	1
PP	14	4	10		2
RA	7		5	2	5
RC	3	1	2		2
RI	51	9	10	32	-
SC	7		1	6	6
SK	7			7	-
TI	10	2	6	2	6
TO	41		1	40	1
TP	5	3	2		1
TV	3			3	1
UC	3	1	2		2
UL	4		3	1	3
UN	3		3		3
Total	367				

Table D.6 EbPi-75 Stone Circle 25 Pronghorn Assemblage

APPENDIX E

Bone Survivorship Data Table and Selected Scan Sites

Element	Composite Density Value	Composite Density Rank	Archaeological Sample	Archaeological Rank
MT	0.46	8	94	1
TI	0.32	13	92	2
MC	0.43	9	87	3
HU	0.24	17	85	4
RA	0.34	12	84	5
FE	0.25	16	84	5
LV	0.12	22	18	6
PE	0.26	15	17	7
CV	0.12	22	14	8
PP	0.36	11	12	9
MP	0.26	15	10	10
TP	0.25	16	9	11
RC	0.68	2	8	12
UL	0.27	14	8	12
INT	0.66	3	8	12
AS	0.48	7	8	12
UC	0.64	5	7	13
CA	0.39	10	6	14
SC	0.21	18	6	14
UN	0.70	1	6	14
MAG	0.65	4	5	15
NC	0.26	15	4	16
AT	0.19	19	4	16
LM	0.63	6	3	17
SV	0.18	20	3	17
AX	0.14	21	2	18
PA	0.39	10	1	19

Table E.1 Most to least abundant archaeological pronghorn element

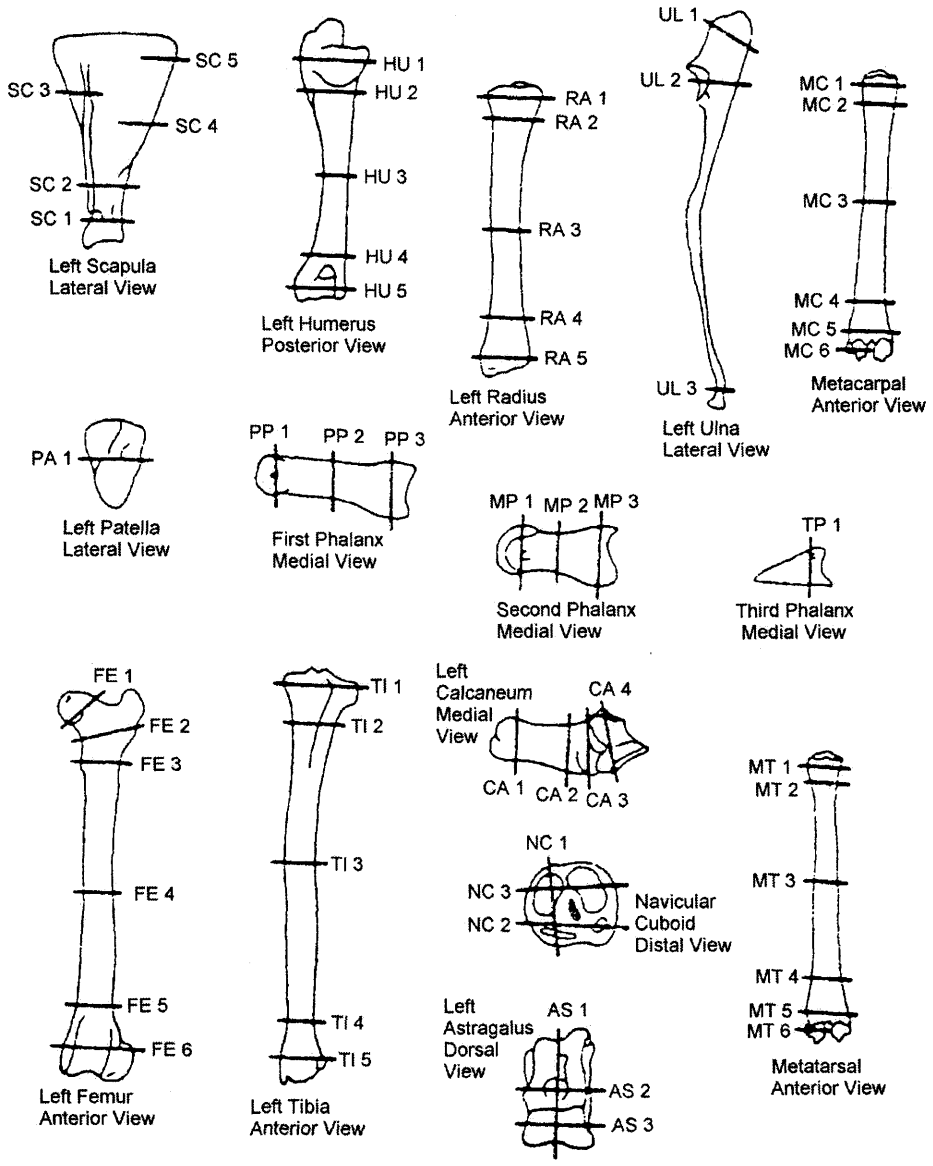

Figure E.1 Selected pronghorn element scan sites
(Adapted from Lyman 1982)

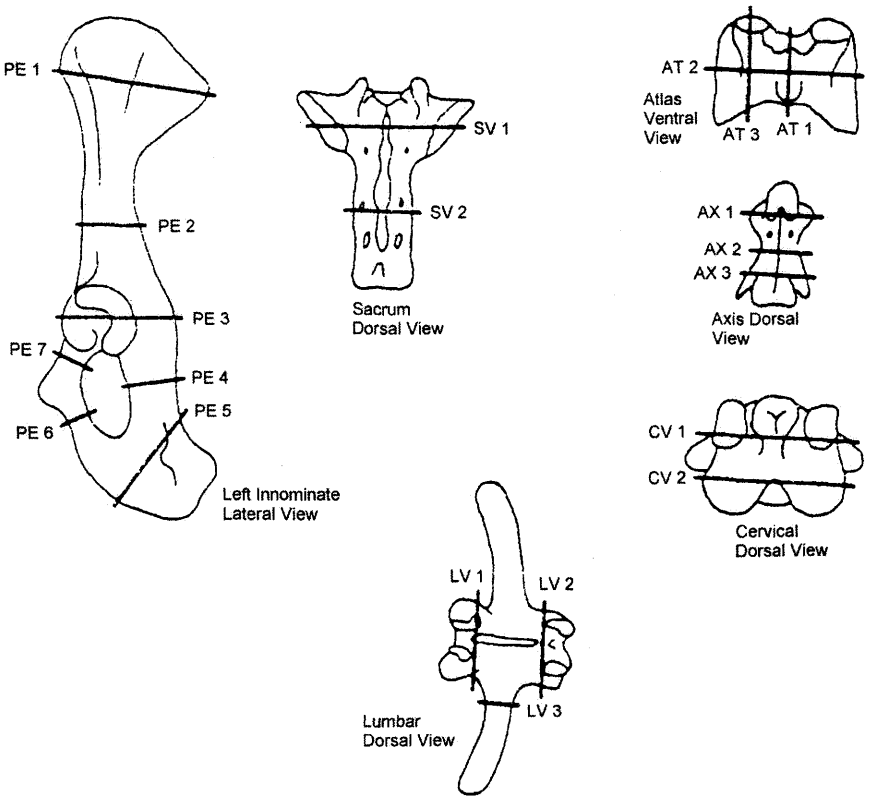

Figure E.2 Selected pronghorn element scan sites
(Adapted from Lyman 1982)